

Hartsfield Atlanta International Airport



Capacity Enhancement Plan Update

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Federal Aviation Administration, City of Atlanta Department of
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Atlanta International Airport.

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EXECUTIVE SUMMARY

Capacity Enhancement Alternatives that provide the most significant delay-savings benefits

Alternatives	Annual Delay Savings			
	Future 1		Future 2	
	Hours	1995 \$ M	Hours	1995 \$ M
• New Independent Runway 9S/27S				
• Arrivals Use Perimeter Taxiway	59,460	\$117.73	191,430	\$379.03
• Arrivals Use Taxiway R	58,690	\$116.20	191,250	\$378.58
• Arrivals Use Taxiway N	59,830	\$118.46	198,780	\$393.58
• Departure/Arrivals on 4 Runways/VAS	54,190	\$107.30	146,050	\$289.18

Note: The delay savings benefits of these improvements are not necessarily additive.

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA), airport operators, and aviation industry groups have initiated joint Airport Capacity Design Teams at various major air carrier airports throughout the U.S. Each Capacity Team identifies and evaluates alternative means to enhance existing airport capacity to handle future demand, decrease delays, and improve airport efficiency. They also develop a coordinated action plan for reducing aircraft delay. Over 35 Airport Capacity Design Teams have either completed their studies or have work in progress.

The need for this program continues. In 1993, 23 airports each exceeded 20,000 hours of airline flight delay. If no improvements in capacity are made, the number of airports that could exceed 20,000 hours of annual aircraft delay is projected to grow from 23 to 29 airports by the year 2004. In addition, the need to update individual studies has become apparent due to the incremental improvements made to existing airports and improvements in procedures and new technologies which have not been previously studied at specific airports.

According to FAA statistics, Hartsfield Atlanta International Airport (ATL), is one of the 23 airports that currently exceeds 20,000 hours of annual airline flight delay. In spite of a drop in traffic in 1991 as a result of the loss of one of its hub airlines and an economic recession, ATL has remained the third busiest airport in the country. Steady traffic growth resumed at the airport in 1992. Traffic increased from 18,811,000 passenger enplanements in 1983 to 25,364,630 in 1994, an increase of over 34 percent. In 1983, the airport handled 600,000 aircraft operations (takeoffs and landings), and, in 1994, 699,400 aircraft operations, an increase of over 16 percent.

The FAA formed a second Airport Capacity Design Team for Hartsfield Atlanta International Airport in late 1985, the first having completed its task in 1980. They published a report containing capacity enhancement recommendations in March of 1987. Subsequent changes in the various computer simulation model inputs, the need to reassess and further analyze capacity enhancement alternatives, and the availability of more advanced modeling tools, resulted in the need to update the report. Therefore, in April, 1994, the FAA formed the third Airport Capacity Design Team for ATL to reassess some of the previously recommended improvements and assess additional im-

provements which, if implemented, would increase ATL's capacity, improve operational efficiency, and reduce aircraft delays. A major benefit of this effort will be its contribution to the City of Atlanta's Master Plan Update, as well as their ongoing studies for ATL expansion. The purpose of the process was to determine the technical merits of each alternative action and its potential to increase capacity and reduce delays. Additional studies will be needed to assess environmental, socioeconomic, or political issues associated with these actions.

Selected improvements identified by the Capacity Team were tested using computer models developed by the FAA to quantify the delay-savings benefits provided. Different levels of activity were chosen to represent growth in aircraft operations in order to compare the merits of each action. These annual activity levels are referred to throughout this report as:

- Baseline — 700,000 operations;
- Future 1 — 850,000 operations;
- Future 2 — 1,000,000 operations

Figure 1 depicts a layout of the airport showing the proposed airfield improvements. Figure 2 lists all of the improvements analyzed by the Capacity Team and shows their delay savings benefits.

Figure 3 illustrates capacity and delay curves for ATL, while Figure 4 profiles ATL daily demand on an hourly distribution basis.

Figure 5 shows how delay will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario. Annual delay costs will increase from 75,050 hours or \$148.60 million at the Baseline level of operations to 177,870 hours or \$348.63 million by Future 1 and 443,210 hours or \$877.56 million by Future 2 with unconstrained demands. Figure 5 also indicates the capacity enhancement alternatives that provide the most significant delay-savings benefits.

Figure 6 illustrates the average delay in minutes per aircraft operation for these alternatives. Under the Do Nothing alternative, if there are no improvements made in airfield capacity, the average delay per operation of 6.4 minutes at the Baseline level of activity will increase to 12.6 minutes per operation by Future 1 and 26.6 minutes per operation by Future 2.

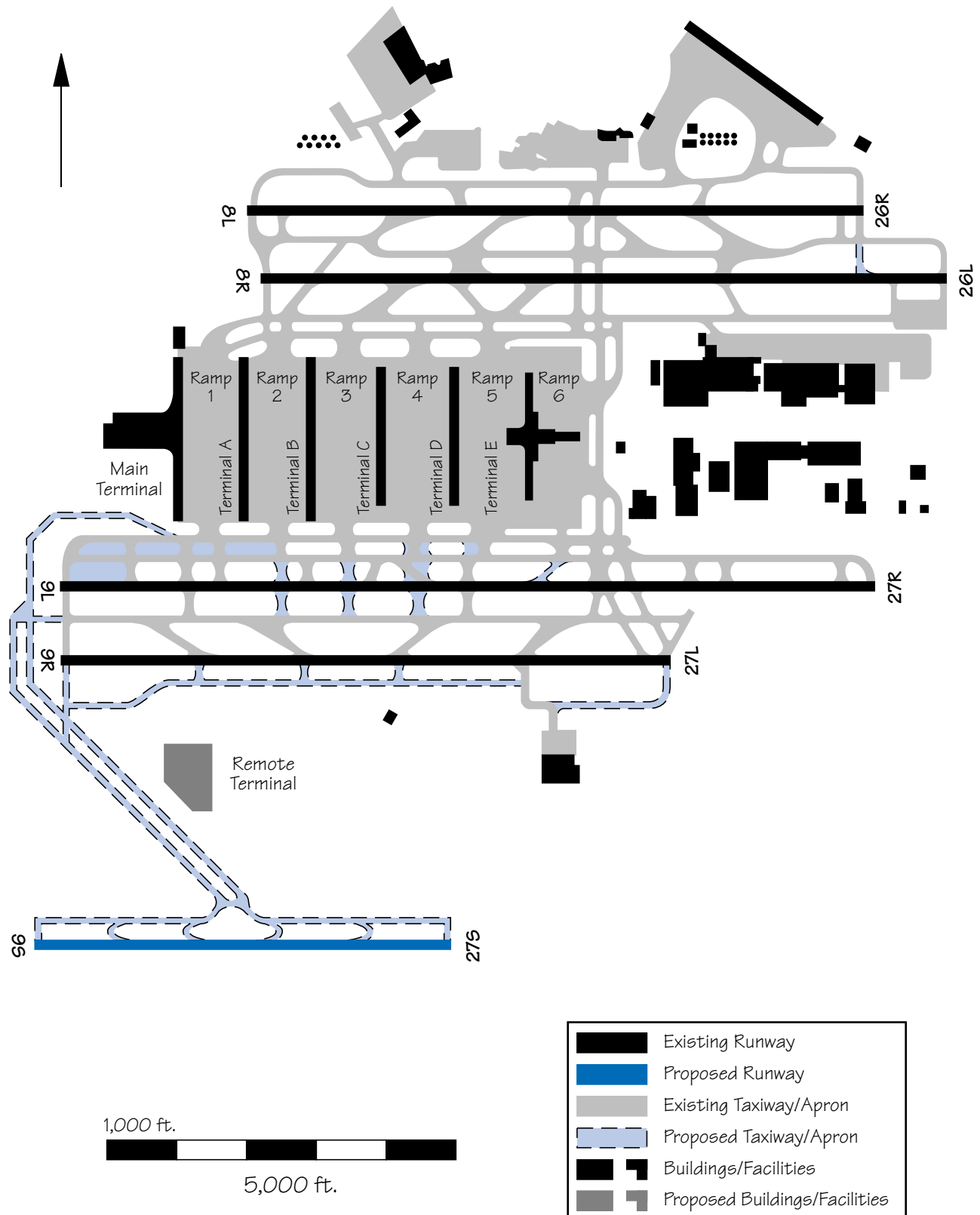
Figure 1. Hartsfield Atlanta International Airport, Atlanta, Georgia

Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings

		Estimated Annual Delay Savings ¹ (in hours and millions of 1995 dollars)		
		Baseline (700,000)	Future 1 (850,000)	Future 2 (1,000,000)
Airfield Improvements				
1.	New Independent Runway 9S/27S (Restricted Use/Arrivals Only)			
a.	Arrivals Use Perimeter Taxiways	11,920/\$23.60	59,460/\$117.73	191,430/\$379.03
b.	Arrivals Use Taxiway R	12,370/\$24.49	58,690/\$116.20	191,250/\$378.58
c.	Arrivals Use Taxiway N	12,640/\$25.03	59,830/\$118.46	198,780/\$393.58
2.	Additional High Speed Runway Exits	*	*	*
3.	Departure Staging Aprons for Runways 9L&27R	*	*	*
4.	Remote Terminal Facilities	13,340/\$26.41	14,680/\$29.06	20,400/\$40.39
5.	Impact of Reconstruction of Existing Runways			
a.	Arrivals and Departures on One Runway	(25,640/\$50.77)	(110,690/\$219.17)	(388,330/\$768.89)
b.	Arrivals and Departures on Three Runways	7,050/\$13.96	(7,680/\$15.21)	(90,670/\$179.53)
Facilities and Equipment Improvements				
6.	CAT II/III ILS on Runways 26R and 27L	*	*	*
7.	CAT IIIB ILS on Runway 8L			
a.	Approaches with less than 600' RVR	*	*	*
b.	Departures with less than 600' RVR	*	*	*
8.	New Independent Runway 9S/27S Approach Aides			
a.	CAT I Approaches	3,850/\$7.63	30,670/\$60.71	84,240/\$166.8
b.	CAT II Approaches	3,090/\$6.11	13,360/\$26.45	22,340/\$44.23
9.	Precision Runway Monitor (PRM); Final Monitor Aids (FMA)	*	*	*
10.	Vortex Advisory System (VAS)			
a.	Departures and Arrivals on Three Runways	16,530/\$32.73	33,890/\$67.10	65,740/\$130.17
b.	Departures and Arrivals on Four Runways	20,960/\$41.50	54,190/\$107.30	146,050/\$289.18
11.	Integrated Terminal Weather System (ITWS)	*	*	*
12.	Airport Research Management Tool (ARMT)/ Surface Movement Advisor (SMA)	*	*	*
Operational Improvements				
13.	Reduced In-Trail Spacing to 2nm (IFR Arrivals)	3,010/\$5.96	16,420/\$32.51	28,250/\$55.94
14.	Departures from 3 or 4 Runways			
a.	Three Departure Runways	3,980/\$7.88	(3,170/\$6.28)	(25,950/\$51.38)
b.	Four Departure Runways	9,680/\$19.17	9,060/\$17.94	(11,920/\$23.60)
c.	Three Departure Runways (Turboprops only on 9R)	5,360/\$10.61	11,600/\$22.10	14,260/\$28.23
15.	Improved Operations on Parallel Runways Separated by less than 2,500' (Reduced Wake Vortex Restrictions for Departure Runways)			
a.	Three Departure Runways	11,660/\$23.09	17,640/\$34.93	24,410/\$48.33
b.	Four Departure Runways	14,180/\$28.08	27,370/\$54.19	37,870/\$74.98
16.	Ramp Control on Ramp 4	*	*	*
User or Policy Improvements				
17.	Uniformly Distribute Scheduled Commercial Operations	*	*	*
18.	Impact of Noise Abatement Restrictions With Current Jet Aircraft Fleet	(7,450/\$14.75)	(12,140/\$24.04)	(29,930/\$59.26)
19.	Enhancement of the Reliever and GA Airport System	*	*	*

1. The delay savings benefits of these alternatives are not necessarily additive and are based on improvements to the existing airfield. Numbers in parenthesis are costs.

* No delay savings were estimated for these alternatives. Descriptions of these improvements are in Section 3 — Capacity Enhancement Alternatives

**Figure 3. Airport Capacity Curves — Hourly Flow Rate Versus Average Delay
50/50 Demand Split East Flow (West Flow Similar)**

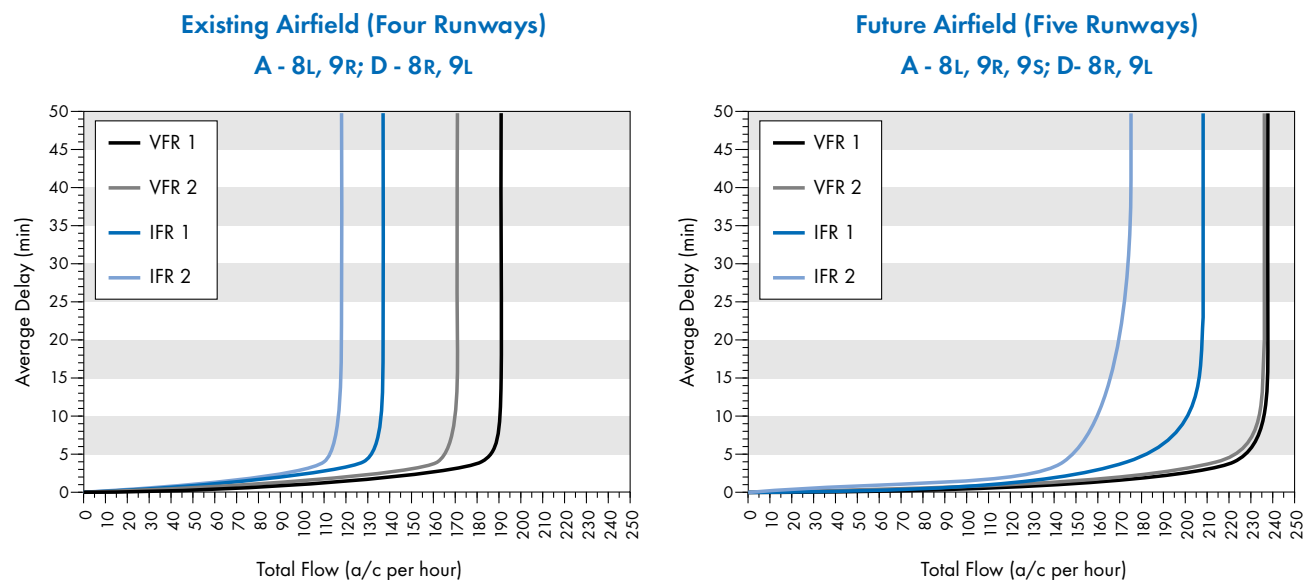


Figure 4. Profile of Daily Demand — Hourly Distribution

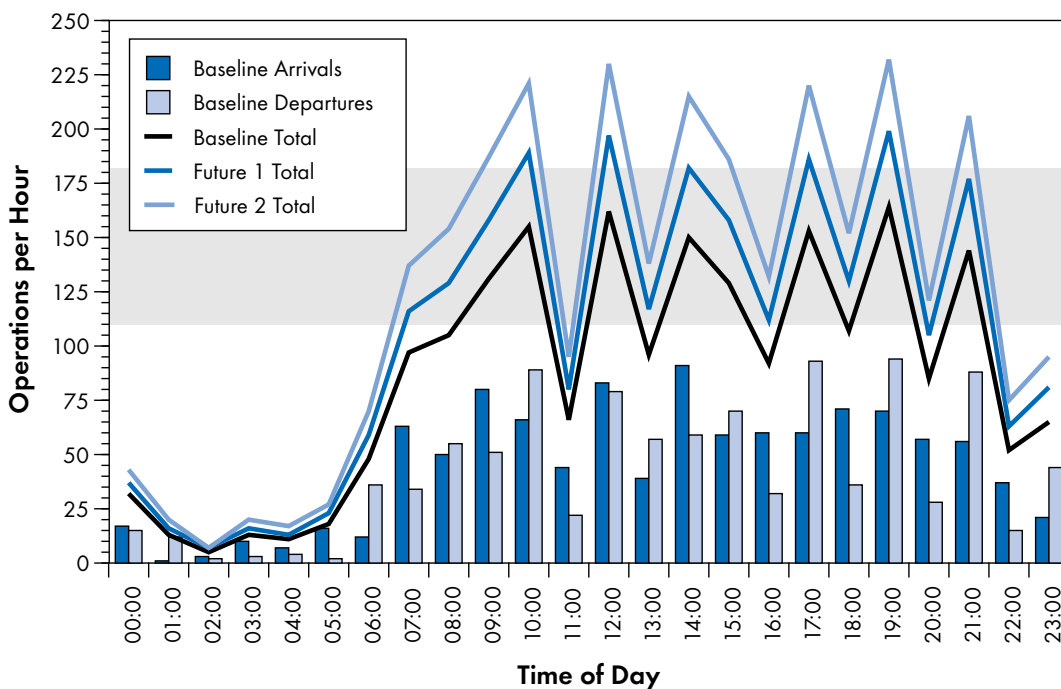
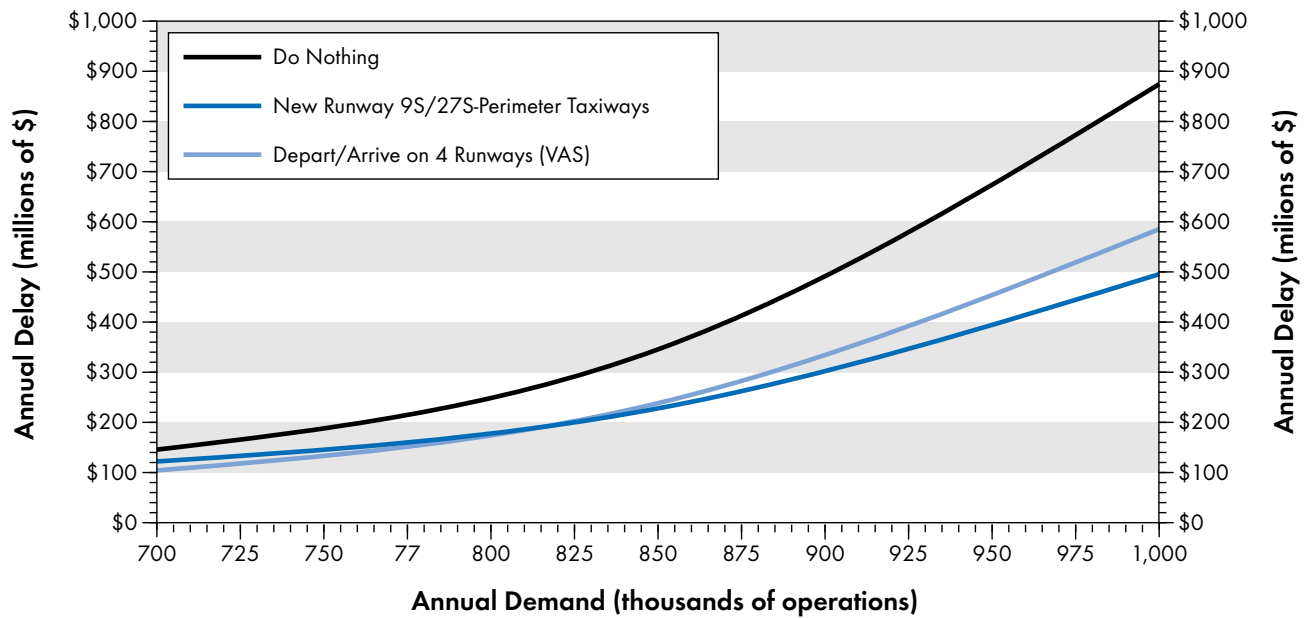
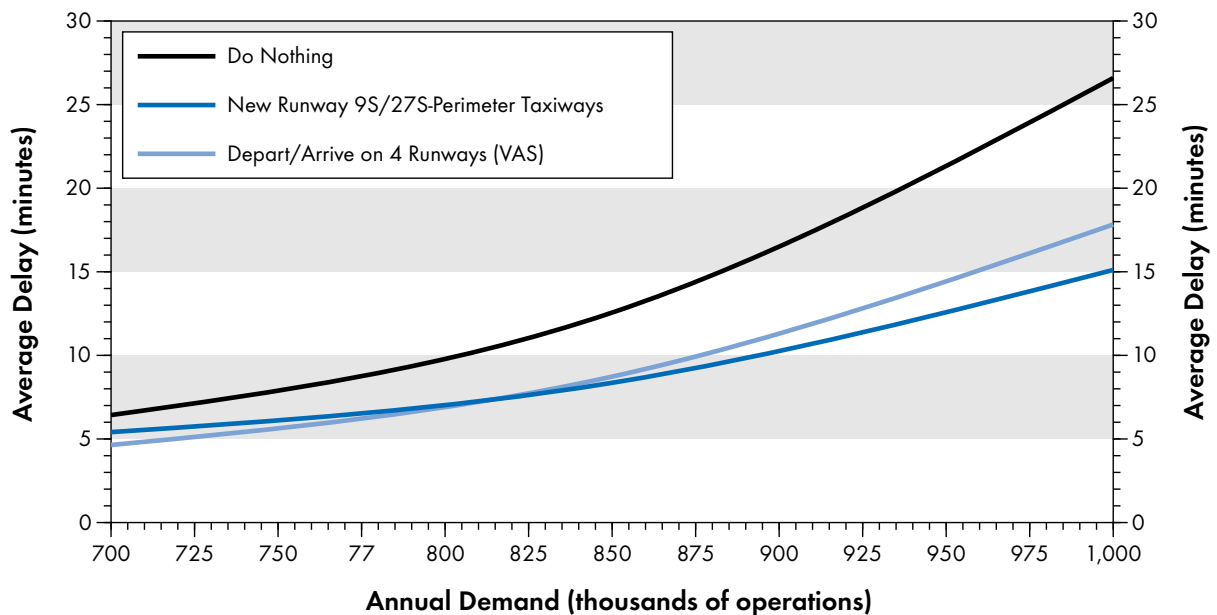


Figure 5. Annual Delay Costs — Capacity Enhancement Alternatives**Figure 6. Average Delays — Capacity Enhancement Alternatives**

SECTION 1

INTRODUCTION

Background

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA) asked the aviation community to study the problem of airport congestion through the Industry Task Force on Airport Capacity Improvement and Delay Reduction chaired by the Airports Council International-North America.

By 1984, aircraft delays recorded throughout the system highlighted the need for more centralized management and coordination of activities to relieve airport congestion. In response, the FAA established the Airport Capacity Program Office, now the Office of Aviation System Capacity (ASC). The goal of this office and its capacity enhancement program is to identify and evaluate initiatives that have the potential to increase capacity, so that current and projected levels of demand can be accommodated within the aviation system with a minimum of delay and without compromising safety or the environment.

In 1985, the FAA initiated a renewed program of Airport Capacity Design Teams at various major air carrier airports throughout the U.S. Each Capacity Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand, and works to develop a coordinated action plan for reducing airport delay. Over 35 Airport Capacity Design Teams have either completed their studies or have work in progress.

The need for this program continues. In 1994, 23 airports each exceeded 20,000 hours of airline flight delays. If no improvements in capacity are made, the number of airports that could exceed 20,000 hours of annual aircraft delay is projected to grow from 23 to 29 by 2004.

In a September 1994 address, the FAA Administrator stated that “the most serious potential problem in meeting the aviation demand in the coming years will be inadequate capacity of our major airports.” He predicted that air travel in the U.S. will increase 60 percent in the next 10 years, and in 20 years, as many as 1 billion passengers annually will pass through our airports. He noted that unless we find a way to add airport capacity, our industry could be forced into distorted patterns of growth... stunted by the unyielding confines of an infrastructure we are unable or unwilling to expand.

The challenge for the air transportation industry in the nineties is to enhance existing airport and airspace capacity and to develop new facilities to handle future demand. As environmental, financial, and other constraints continue to restrict the development of new airport facilities in the U.S., an increased emphasis has been placed on the re-development and expansion of existing airport facilities.

Hartsfield Atlanta International Airport

Hartsfield Atlanta International Airport (ATL) is one of the 23 airports that, according to FAA statistics, exceeds 20,000 hours of annual aircraft delay. In the past decade, ATL has been one of the Nation's busiest airports. Passenger enplanements at ATL rose from 18,811,000 in 1983 to 24,134,000 in 1990, an increase of over 28 percent. ATL's total aircraft operations (one takeoff or one landing equals one operation) reached 779,000 in 1990, an increase of 30 percent over the 600,000 aircraft operations the airport handled in 1983. In 1991, ATL's activity dropped to 18,887,000 enplanements and 640,000 operations as a result of economic recession and the loss of one of its two hub airlines. However, in 1992, strong traffic growth resumed and in 1994, ATL handled 25,364,630 enplanements and 699,400 operations.

Hartsfield Atlanta International Airport is owned and operated by the City of Atlanta. The airport is currently situated on about 3,750 acres and is at an elevation of 1,026 feet above mean sea level. The airfield has two pairs of closely spaced parallel runways separated by the first midfield terminal complex in the United States specifically designed for hub operations. The airport is capable of handling dual arrival streams; however, departure procedures are highly restricted due to noise abatement requirements.

Hartsfield Atlanta International Airport Capacity Design Team

The FAA formed an Airport Capacity Design Team in late 1985 to identify and analyze alternative means of enhancing ATL's capacity to meet growing demand. The Design Team published an Airport Capacity Enhancement Plan for ATL in March 1987. They recommended a total of 15 airfield, facilities and equipment, air traffic control, and airport user improvements. These improvements included such actions as the construction of a fifth concourse, construction of a south commuter runway and terminal complex, upgrading terminal approach radar, reducing IFR arrival separations to 2.5nm, and de-peak airline schedules. Many of these improvements have been, or are in the process of being, implemented.

By 1994, there had been changes in various airport operational parameters, such as the aircraft fleet mix, average aircraft approach speeds, aircraft arrival separations, and the daily demand profile. Also, more advanced modeling tools were available. Therefore, in late April, 1994, the FAA formed the second Airport Capacity Design Team for ATL to reassess potential improvements which, if implemented, would increase ATL's capacity, improve operational efficiency, and reduce aircraft delays. This Capacity Enhancement Plan Update was undertaken to determine the technical merits of the improvements. Additional studies will be needed to assess associated environmental, socioeconomic, or political issues. A major benefit of this effort will be its positive contribution to the proposed Hartsfield Atlanta International Airport Master Plan Update.

This report establishes milestones for development based upon traffic levels, not upon any definitive time schedule, since actual growth can vary year to year from projections. As a result, this report should retain its validity until the highest traffic level is attained, regardless of when it occurs.

A Baseline of 700,000 aircraft operations (takeoffs and landings) was established based on the estimated annual traffic level for 1994. Two future traffic levels, Future 1 and 2, were established at 850,000 and 1,000,000 annual aircraft operations respectively, based on Capacity Team consensus of potential traffic growth at ATL.

If no improvements are made at ATL, annual delay levels and delay costs are expected to increase from an estimated 75,050 hours and \$148.60 million at the Baseline activity level to 177,870 hours and \$348.63 million by the Future 1 demand level; and 443,210 hours and \$877.56 million by Future 2.

The Capacity Team studied various proposals with the potential for increasing capacity and reducing delays at ATL. The improvements evaluated by the Capacity Team are listed in Figure 2 and described in some detail in Section 3 — Capacity Enhancement Alternatives.

Objectives

The major goal of the Capacity Team was to identify and evaluate proposals to increase airport capacity, improve airport efficiency, and reduce aircraft delays. In achieving this objective, the Capacity Team:

- Assessed the current airport capacity.
- Examined the causes of delay associated with the airfield, the immediate airspace, and the apron and gate-area operations.
- Evaluated delay savings benefits of alternative operational procedure improvements, facilities and equipment improvements, airfield improvements, and user or policy improvements.

Scope

The Capacity Team limited their analyses to aircraft activity on the airfield, including the runways, taxiways, aprons, and gate areas. They did not consider aircraft activity in the terminal or en-route airspace. Furthermore, they considered the operational benefits of the proposed airfield improvements, but did not address environmental, socioeconomic, or political issues regarding airport development. These issues need to be addressed in future airport planning studies, and the data generated by the Capacity Team can be used in such studies.

Methodology

The Capacity Team, which included representatives from the FAA, the City of Atlanta, and various aviation industry groups (see Appendix A), met periodically for review and coordination. The Capacity

Team members considered capacity improvement alternatives proposed by the FAA's Office of Aviation System Capacity, Technical Center, and Regional Airport Capacity Program Manager, and by other members of the Team. Alternatives that were considered practicable were developed into experiments that could be tested by airport simulation modeling. The FAA Technical Center's Aviation System Analysis and Modeling Branch provided expertise in airport simulation modeling. The Capacity Team validated the data used as input for the simulation modeling and analysis and reviewed and interpreted the simulation results. The data, assumptions, alternatives, and experiments were continually reevaluated, and modified where necessary, as the study progressed. A primary goal of the study was to develop a set of capacity-enhancing recommendations, complete with planning and implementation time horizons.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis and modeling. Where possible, assumptions were based on actual field observations at ATL. Proposed improvements were analyzed in relation to current and future demands utilizing two FAA computer models, the Airport and Airspace Simulation Model (SIMMOD) and the Runway Delay Simulation Model (RDSIM). Appendix B briefly explains the models.

The simulation modeling considered air traffic control procedures, airfield improvements, and traffic demands. Terminal and en route airspace was not modeled. Alternative airfield configurations were prepared from present and proposed airport layout plans. Various configurations were evaluated to assess the benefit of projected improvements. Air traffic control procedures and system improvements determined the aircraft separations to be used for the simulations under both VFR and IFR conditions. Due to the high cost and extensive time requirements of modeling, the East operation was selected as being representative of the overall operation. Accordingly, simulation results were annualized and weighted so as to present values for all directions and durations of operations.

Air traffic demand profiles were derived from *Official Airline Guide* data, historical data, and Capacity Team and other forecasts. Aircraft volume, mix, and peaking characteristics were considered for each of the three different demand levels (Baseline, Future 1, and Future 2). From this, annual delay estimates were determined based on implementing various improvements. These estimates took into account historic variations in runway configuration, weather, and demand. The annual delay estimates for each configuration were then compared to the annual delay estimate for the existing airfield configuration to identify delay reductions resulting from the improvements. Following the evaluation, the Capacity Team developed a plan of recommended alternatives for implementation.

SECTION 2

COMPARISON OF THE 1987 AND 1995 CAPACITY ENHANCEMENT PLANS

Data was collected in 1986 for the Capacity Enhancement Plan (CEP) published in 1987. Data for the 1995 update was collected in 1994 and differs somewhat from that used in the 1987 study as shown in the selected graphics in this section. These differences have generally led to a reduction in the delay estimates in the 1995 study relative to those in the 1987 study.

Changes Since Publication of the 1987 Capacity Enhancement Plan

Several changes have occurred at ATL since the 1987 CEP was published. These changes include:

- Greater peaking of the daily demand profile.
- An increase in average aircraft approach speeds.
- Changes in the aircraft fleet mix.
- Changes in aircraft approach procedures.
- Changes in aircraft arrival separation criteria.
- Introduction of Boeing 757 aircraft criteria.

A Comparison of the 1987 and 1995 studies at Atlanta reflects differences in demand levels, peaking characteristics, hub operations, and aircraft operations. The demand levels in the 1987 study range from 2,250 to 2,390 daily or 775,000 to 797,000 annual operations. In the 1995 study, the demand levels ranged from 2,090 to 3,000 daily or 700,000 to 1,000,000 annual operations. The operational change reflects a 2.5nm arrival-to-arrival separation, under IFR conditions, which has been implemented since the 1987 study.

Aircraft operations in the 1987 study were analyzed using four aircraft classes, heavy, large, small twins, and single engine. Each class was defined as follows:

- Class 1 - Heavy aircraft weighing more than 300,000 pounds.
- Class 2 - Large aircraft weighing 12,500 to 300,000 pounds.
- Class 3 - Small aircraft (e.g., twin engine props) weighing less than 12,500 pounds.
- Class 4 - Small aircraft (e.g., single-engine props) weighing less than 12,500 pounds.

The aircraft mix remained essentially the same for all demand levels in the 1987 study, while standard approach speeds and separation values were assigned to each class of aircraft. The aircraft mix for heavy, large, twins, and singles was 11 percent, 72 percent, 16 percent, and 3 percent respectively.

Aircraft operations in the 1995 study were analyzed using six classes, specifically to accommodate operations on the proposed new runway with the option to accommodate small jets and props or only

props less than 100,000 pounds. Additionally, a class was devised to reflect current criteria applied to the B-757, which differs from that applied to large aircraft. Each class was defined as follows:

- Class 1 - Heavy aircraft weighing more than 300,000 pounds.
- Class 2 - Boeing 757s.
- Class 3 - Large aircraft weighing 100,000 to 300,000 pounds.
- Class 4 - Large aircraft (jets) weighing 12,500 to 100,000 pounds.
- Class 5 - Large aircraft (turboprops) weighing 12,500 to 100,000 pounds.
- Class 6 - Small aircraft (twin and single engine props) weighing less than 12,500 pounds.

The aircraft mix varied at the three demand levels. Approach speeds adopted for this study were higher than the standard approach speeds. Both approach speeds and separation values specifically were determined from Atlanta ARTS data. The aircraft mix for the 1995 study showed an increase in the percentage of heavies from 11 percent to 15 percent, and an increase in the percentage of large from 72 percent to 82 percent. Conversely, the percentage of small aircraft decreased from 23 percent to 17 percent. These differences changed the characteristics of the operations at Atlanta. The operating characteristics also differed because of the change in peaking characteristics resulting from the change from a two hub to a one hub operation as reflected in the hourly distribution on the daily demand profiles of the two studies.

Information Comparisons

The following figures provide a comparison of the information used in the 1987 and 1995 studies.

As seen in Figure 7, an analysis of capacity calculations for the 1987 and 1995 studies show that IFR arrival and departure capacity has increased by a substantial amount. This is due to the 2.5nm separation standard and increased approach speeds since the 1987 study.

Figure 8 depicts approach speeds and fleet mix by aircraft class for both the 1987 and 1995 studies. Approach speeds have generally increased for all aircraft classes. As indicated previously, this has increased arrival capacity.

As depicted in Figures 9 and 10, a comparison of the baseline daily demand level for the 1987 and 1995 studies shows that, in 1987, two fairly distinct peak demand periods were evident, while in 1995, peak demand levels occurred at least 6 times during the operational day with a minimal time span separating them. This reflects the difference between a two-hub operation in 1987 and a one-hub operation in 1995, as well as airline initiatives to deconflict the schedule. Therefore, in 1987, demand was relatively constant and there was little time to recover from delays. In 1995, the periods of relatively low demand between the peak periods allowed some time to recover from delays dur-

ing the peak periods. As a result, delays are somewhat reduced by the daily demand profile existing in 1995 relative to that existing in 1987.

In summary, the major factors causing differences in the 1987 and 1995 simulation model delay estimates are: 1) a new National aircraft separation standard of 2-1/2nm in-trail separation of non-heavy like aircraft for IFR arrivals; 2) an increase in aircraft approach speeds; 3) the dual versus single airline hub operations; and 4) changes in the aircraft fleet mix.

Figure 7. IFR Capacity – Comparison

1987 Study

		Arrivals	Departures	Total
Current	IFR	49	49	98
Future	IFR	50	50	100

1995 Study

		Arrivals	Departures	Total
Current	IFR 1	64	64	128
	IFR 2	55	55	110
Future	IFR 1	86	86	172
	IFR 2	72	72	144

Figure 8. Aircraft Fleet Mix & Approach Speed — Comparison**Typical Approach Speed (1987 Study)**

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
VFR 1 & 2	140	130	120	100	n/a	n/a
IFR 1	140	130	120	100	n/a	n/a
IFR 2	140	130	120	100	n/a	n/a

Typical Approach Speed (1995 Study)

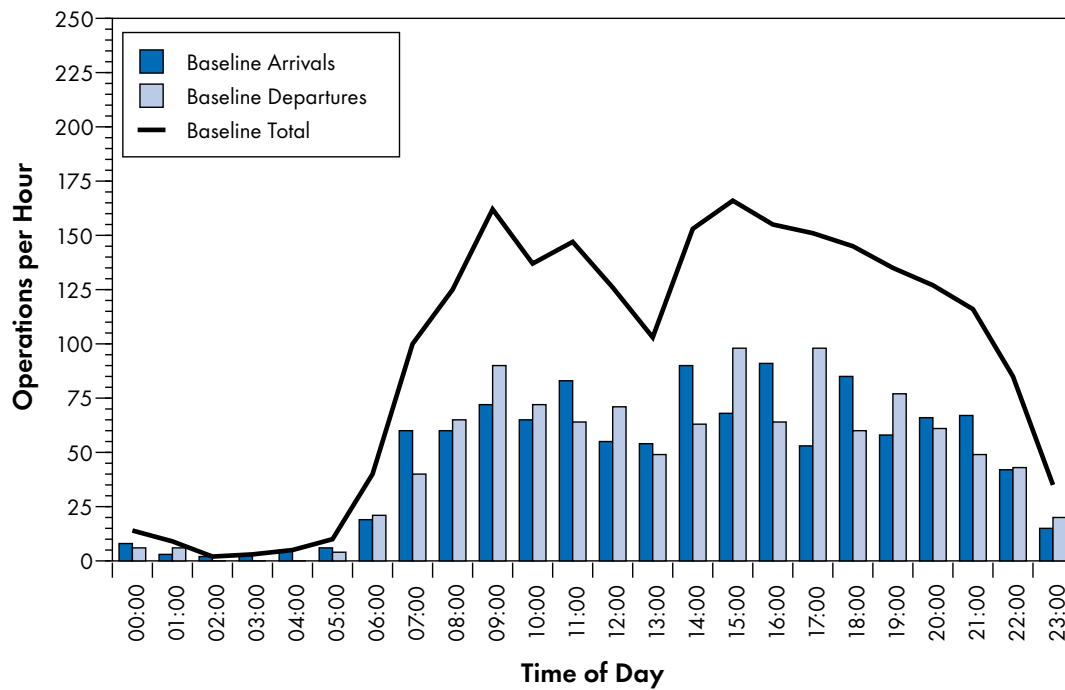
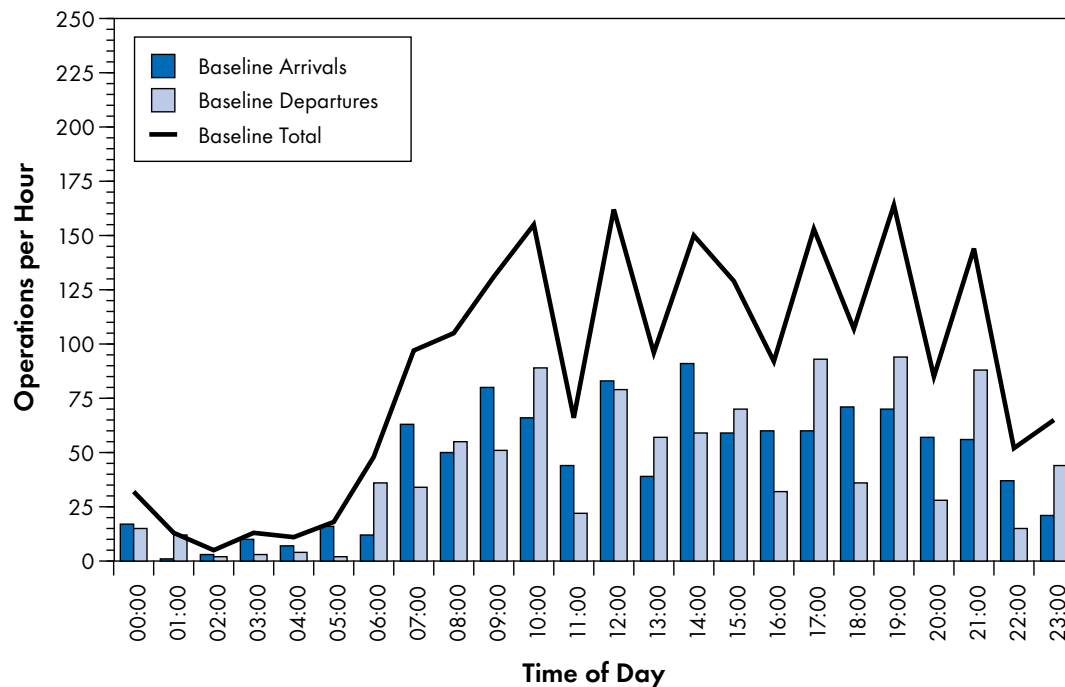
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
VFR 1 & 2	156	143	154	147	147	153
IFR 1	150	140	140	140	140	135
IFR 2	140	130	130	130	130	120

Typical Fleet Mix (1987 Study)

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Baseline	11%	71%	17%	1%	n/a	n/a
Future 1	11%	72%	16%	1%	n/a	n/a
Future 2	11%	72%	16%	1%	n/a	n/a

Typical Fleet Mix (1995 Study)

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Baseline	15%	8%	51%	4%	19%	3%
Future 1	15%	12%	45%	5%	20%	3%
Future 2	16%	14%	41%	5%	22%	2%

Figure 9. 1987 Profile of Daily Demand — Hourly Distribution**Figure 10. 1995 Profile of Daily Demand — Hourly Distribution**

SECTION 3

CAPACITY ENHANCEMENT ALTERNATIVES

Background

The capacity enhancement alternatives are categorized and discussed under the following headings:

- Airfield Improvements.
- Facilities and Equipment Improvements.
- Operational Improvements.
- User or Policy Improvements.

Individual improvement discussions include the Team's rationale for their recommended action. Further, where applicable, delay savings are presented for the alternative being discussed. Please note that the delay savings benefits listed with the improvements are not necessarily additive.

Figure 1 shows the current layout of the airport, plus the airfield improvements considered by the Capacity Team.

Figure 2 lists the capacity enhancement alternatives evaluated by the Capacity Team and presents the estimated annual delay savings benefits for selected improvements. The annual delay savings are given for the activity levels Baseline, Future 1, and Future 2, which correspond to annual aircraft operations of 700,000, 850,000, and 1,000,000 respectively. The delay savings benefits of the improvements are not necessarily additive.

Figure 11 presents the recommended action and suggested time frame for implementation of each capacity enhancement alternative considered by the Capacity Team.

Figure 11. Capacity Enhancement Alternatives Studied and Recommended Actions

		Recommended Action	Time Frame
Airfield Improvements			
1.	New Independent Runway 9S/27S - Restricted Use/Arrivals Only	Implement	Future 1
	a. Arrivals Use Perimeter Taxiway		
	b. Arrivals Use Taxiway R		
	c. Arrivals Use Taxiway N		
2.	Additional High Speed Runway Exits	Implement	Baseline
3.	Departure Staging Aprons for Departure Runways 9L & 27R	Implement	Baseline
4.	Remote Terminal Facilities	Further Study	
5.	Impact of Reconstruction of Existing Runways		
	a. Arrivals and Departures on One Runway	Do Not Implement	
	b. Arrivals and Departures on Three Runways	Implement	During Reconstruction
Facilities and Equipment Improvements			
6.	CAT II/III ILS on Runways 26R and 27L	Implement	Baseline
7.	CAT IIIB ILS on Runway 8L	Implement	Baseline
	a. Approaches less than 600' RVR		
	b. Departures with less than 600' RVR		
8.	New Independent Runway 9S/27S Approach Aids		
	a. CAT I Approaches	Implement	Future 1
	b. CAT II Approaches	Implement	Future 1
9.	Precision Runway Monitor (PRM) Final Monitor Aid (FMA)	Implement	Future 1
10.	Vortex Advisory System (VAS)	Implement	When Available
	a. Departures and Arrivals on Three Runways		
	b. Departures and Arrivals on Four Runways		
11.	Integrated Terminal Weather System (ITWS)	Implement	Baseline
12.	Airport Research Management Tool (ARMT)/ Surface Movement Advisor (SMA):	Implement	Baseline
Operational Improvements			
13.	Reduced In-Trail Spacing to 2nm (IFR Arrivals)	Further Study	
14.	Departures from 3 or 4 Runways		
	a. Departures from Three Runways	Do Not Implement	
	b. Departures from Four Runways	Do Not Implement	
	c. Departures from Three Runways (Turboprops only on 9R)	Implement	Baseline
15.	Improved Operations on Parallel Runways Separated by less than 2,500' (Reduced Wake Vortex Restrictions for Departure Runways)	Implement	Future 1
	a. Departures from Three Runways		
	b. Departures from Four Runways		
16.	Ramp Control on Ramp 4	Implement	Baseline
User or Policy Improvements			
17.	Uniformly Distribute Scheduled Commercial Operations	Do Not Implement	
18.	Impact of Noise Abatement Restrictions With Current Jet Aircraft Fleet	Further Study	
19.	Enhancement of the Reliever and GA Airport Systems	Implement	Baseline

Airfield Improvements

1. New Independent Runway 9S/27S — Restricted Use/Arrivals only.

A fifth, parallel “commuter” runway located approximately 4,200 feet south of Runway 9R/27L would provide the airport with triple, simultaneous, Instrument Meteorological Conditions (IMC) arrival capability. This runway would be “restricted” in the sense that it would be intended to handle aircraft that meet FAR Part 36, Stage 3 noise restrictions and weigh less than 100,000 pounds maximum gross landing weight. Its use would initially be limited to primarily arriving aircraft.

Presently, approximately 70 percent of the airport’s commuter traffic arrives from south of Atlanta. Locating the runway south of the existing airfield would allow the commuter arrivals from the south, and some from the north, to fly directly to the runway’s final approach course without competing with larger aircraft for an arrival runway. A runway dedicated to handle these aircraft during peak arrival periods would not only reduce airborne delay for the commuter aircraft, but for the air carrier aircraft operating on the four existing runways as well. During non-peak periods, commuter aircraft from the south would continue to land on existing Runway 9R/27L. Commuter aircraft from the north would continue to land on existing Runway 8L/26R.

The Capacity Team recognizes that environmental limitations require restricted use of the runway initially (i.e., aircraft less than 100,000 pounds maximum gross weight and primarily arrivals only). However, the Team recommends revisiting these environmental issues in the future for possible removal of the restrictions to achieve maximum benefit of the runway.

Additional engineering study and design over the past year, particularly to address FAA standards and roadway/tunnel/ventilation design, have increased the estimated project cost to \$400 million.

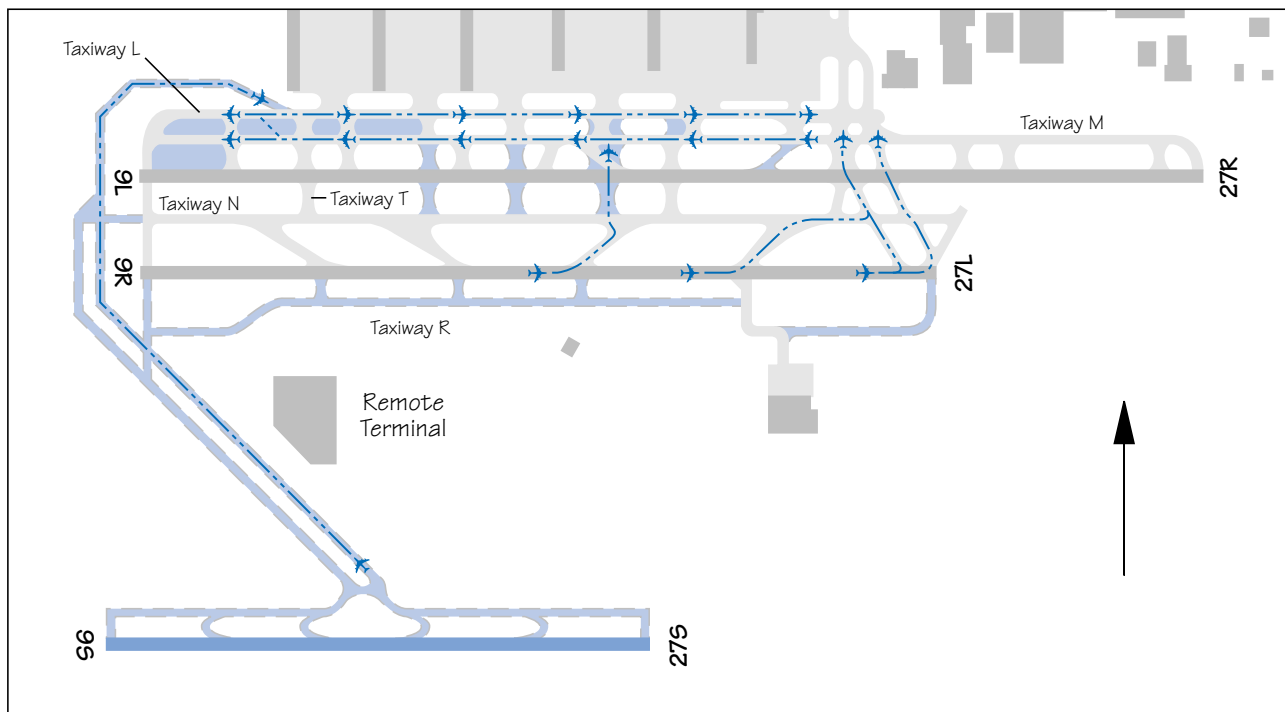
The Capacity Team recommends that this improvement be implemented at the Future 1 demand level. Since terminal and en route airspace was not modeled, this recommendation is based only on airport capacity benefits.

A. Arrivals Use Perimeter Taxiway

The Capacity Team considered three taxiway routing alternatives to allow aircraft access to the new commuter runway. The first option involved the construction of a “perimeter” taxiway. Runway crossings not only require extra coordination between the ground controller and local controller, but can also result in delays between successive arrivals or departures. The construction of perimeter taxiways would allow aircraft to taxi to and from the new runway without crossing an active runway and without being stopped at each runway crossing location. Perimeter taxiways have the potential to reduce controller workload, enhance safety with fewer opportunities for runway incursion, increase departure capacity, and reduce taxiing delays.

Under this scenario, aircraft would taxi from the commuter runway through the Runway 9L and 9R approach areas, around the north-west corner of Taxiway L, and tie into Taxiway L approximately at the Taxiway L/Taxiway T intersection. This alternative would not require commuter runway arrivals to cross any active runway. However, special queuing and taxiing procedures would need to be developed for the Runway 9L departure area during an east operation. Also, having commuter aircraft flowing east on L could present a problem for 9R arrivals trying to reach Ramps 1 and 2 and needs further study.

Annual delay savings at the Baseline activity level would be 11,920 hours or \$23.60 million; at Future 1, 59,460 hours or \$117.73 million; and, at Future 2 activity levels, 191,430 hours or \$379.03 million.

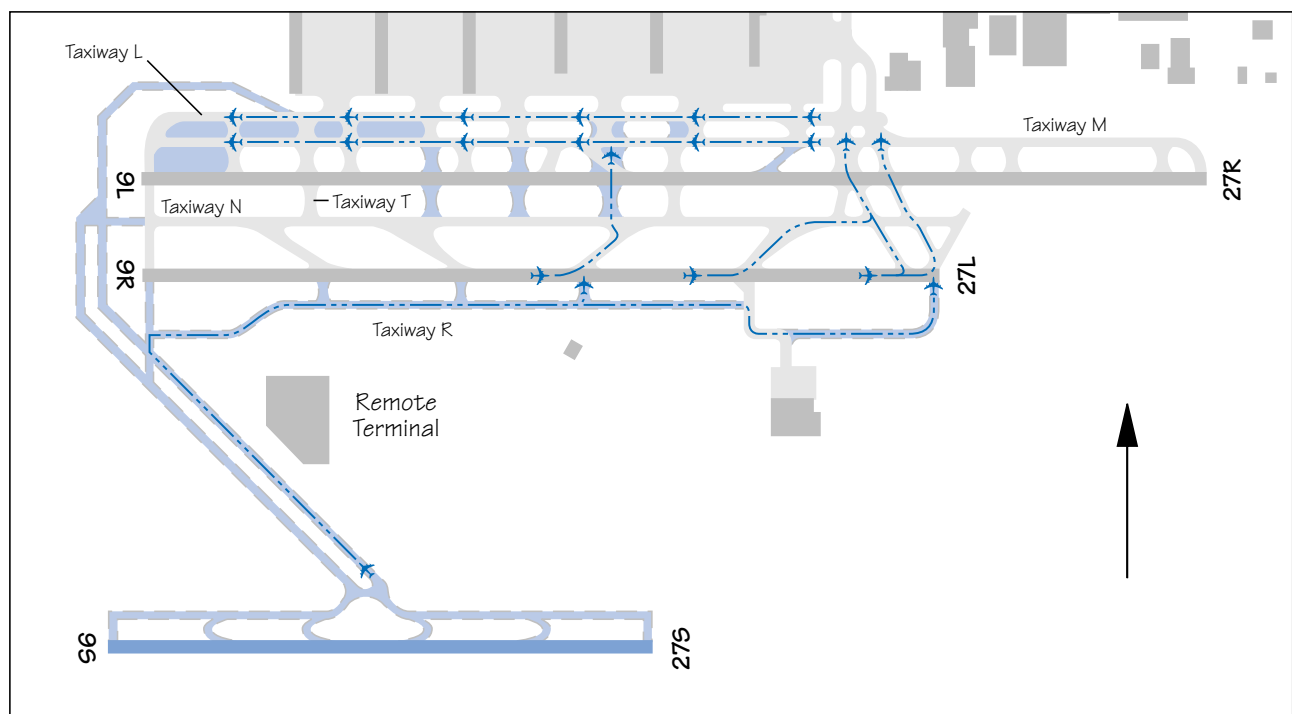


B. Arrivals Use Taxiway R

The second option considered would have commuter runway arrivals taxi back to the terminal complex via proposed Taxiway R. Taxiway R is a proposed parallel taxiway located south of existing Runway 9R/27L. Aircraft would taxi north until intersecting Taxiway R, then taxi down R to an appropriate point at which to cross Runway 9R/27L. After crossing this runway, they would then need to cross Runway 9L/27R. Thus, for both an east and west operation, commuter runway arrivals would be required to cross two active runways. The computer simulations used in this study calculate delay incurred by aircraft crossing active runways, however, Capacity Team members stressed that the simulations did not account for the resulting added controller workload when handling runway crossings.

Most runway crossings require coordination between controllers (ground and local). This human interaction requires the two controllers have the same period of time to pause, listen, receive and acknowledge information. As traffic activity increases, the available time when two or more controllers can close this communications loop decreases dramatically.

Taxi routes which require no runway crossing are optimum. Taxi routes which reduce controller coordination are preferred if no other option is available. Further thoughtful development of ATC procedures will focus on near approach end crossing points and taxi routes which will facilitate more efficient runway crossing.



The SIMMOD computer model used to simulate Alternatives 1a, b, and c with runway crossings simply calculates whether there is time for an aircraft to cross a runway. The SIMMOD program does not consider any other complexities. No calculation is made to determine the overall demand on the airport complex, the demand on the ground or local controller to listen, acknowledge or transmit a clearance. Further, no calculation is made which addresses pilot response time, aircraft configuration (single engine operation) or company operating policies.

The delay cost analysis generated by the SIMMOD modeling program must therefore be viewed as a highly optimistic estimate. We expect that the numerous operating practices and complexities associated with a heavy ATC workload during an arrival and departure push would result in significantly lower estimated savings and greater delay estimates.

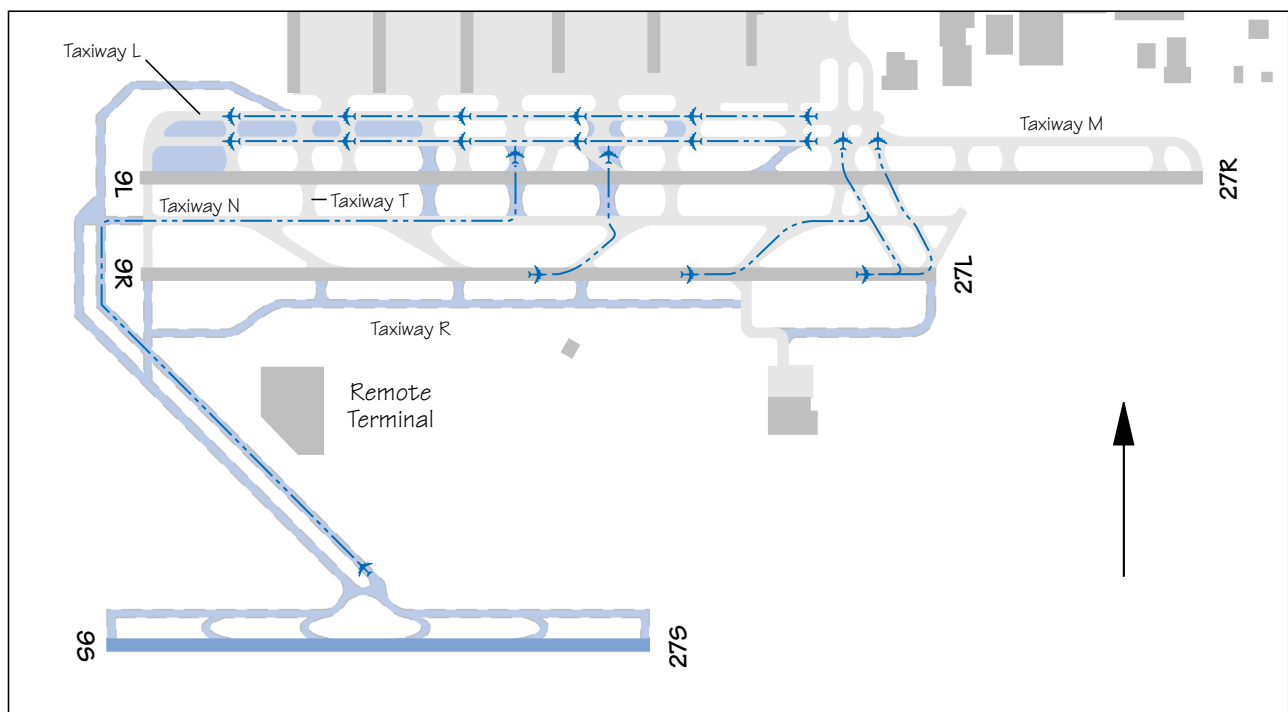
Prior to any decision to select or recommend an optimum taxi alternate, the complexities described above must be addressed as part of any complete analysis and decision making process. The selection of an optimum alternative must include an analysis that considers potential runway crossing conflicts, runway incursions, controller workload, pilot response time, potential aircraft configurations, and various company operating practices which can result in a less than timely response when executing a runway crossing.

Annual delay savings at the Baseline activity level would be 12,370 hours or \$24.49 million; at Future 1, 58,690 hours or \$116.20 million; and, at Future 2 activity levels, 191,250 hours or \$378.68 million.

C. Arrivals Use Taxiway N

Option three would have commuter runway arrivals taxi through the Runway 9R approach area and then turn onto Taxiway N. Taxiway N is a parallel taxiway located between Runways 9L/27R and 9R/27L. Aircraft would taxi down N and eventually cross Runway 9L/27R into the terminal area. This option would require 9L/27R runway crossings while eliminating Runway 9R crossings outlined in the second option above. The increased number of crossings would result from additional jet aircraft that would be routed to Runway 9R/27L from Runway 8L/26R to balance arrivals to the existing runways as a result of gaps created by the removal of commuter aircraft from the Runway 9R/27L arrival stream. Again, the computer simulations used for this study did not account for the added controller workload that would result due to runway crossings. However, there would be some offsetting workload reduction on the north runway complex due to the decrease of Runway 8R/26L crossings. Taxiway grades may be a problem in getting to Taxiway N and need further study.

Annual delay savings at the Baseline activity level would be 12,640 hours or \$25.03 million; at Future 1, 59,830 hours or \$118.46 million; and, at Future 2 activity levels, 198,780 hours or \$393.58 million.



2. Additional High Speed Runway Exits.

High-speed exits are designed to facilitate aircraft exiting the runway. Right-angle exits require aircraft to come to almost a complete stop before exiting the runway. High-speed exits enable aircraft to exit the runway at speeds ranging from 35 to 60 knots. The design and location of runway exits affect aircraft arrival runway occupancy times (ROT's). For arrivals, poorly placed exits can result in longer ROT's and larger arrival-to-arrival separations than would otherwise be required for normal airspace or wake turbulence considerations. Poorly placed runway exits can also reduce the departure capacity of runways used for both arrivals and departures because excessive arrival ROT's decrease the number of opportunities for releasing departures.

In the future, this will become increasingly important due to re-construction of all existing runways. Exit improvements are already in the planning stages for the inboard runways in anticipation of this event. The Design Team is confident, because of this and previous efforts by ATL, that when future procedures or rules require reduced occupancy times, appropriate action will be taken.

The Capacity Team recommends that this improvement be implemented as soon as possible.

3. Departure Staging Aprons for Runways 9L & 27R.

The Runway 27R threshold is accessible only by queuing aircraft on Taxiway M. Construction of a staging apron near the Runway 27R threshold would allow air traffic controllers to pull certain aircraft out of the departure queue and bypass aircraft waiting for departure clearance. Aircraft are often required to hold at the runway threshold before takeoff because of departure flow restrictions, aircraft mechanical problems, and required ground holds due to weather conditions at a destination airport. Therefore, the staging apron would provide controllers with more flexibility in sequencing aircraft and would reduce departure queue delay, and facilitate anti-icing activities. Paving the area between Taxiway L and Taxiway M near the Runway 9L threshold would provide similar benefits during an east operation.

Estimated project cost is \$5.5 million.

The Capacity Team recommends that this improvement be implemented as soon as possible.

4. Remote Terminal Facilities.

The gate capacity of the existing terminal complex may eventually be exceeded. Operations by aircraft weighing less than 100,000 pounds are expected to increase. Assuming that the commuter runway, if constructed, would be handling many of these aircraft, future conditions may warrant construction of a remote terminal south of the existing airfield to handle these operations.

To determine the benefits of a remote terminal, the computer model assumed that aircraft landing on the fifth runway would utilize the remote terminal. While the model showed savings for this type of operation, it did not address the significant cost or burden that would

be involved in connecting passengers to a major airline at the main airport complex. No consideration was given to the movement of connecting passengers or connecting bags.

The Capacity Team recommends that a further, more detailed study be conducted before this improvement is implemented.

Annual delay savings at the Baseline activity level would be 13,340 hours or \$26.41 million; at Future 1, 14,680 hours or \$29.06 million; and, at Future 2 activity levels, 20,400 hours or \$40.39 million.

5. Impact of Reconstruction of Existing Runways.

The City of Atlanta will be reconstructing some of the airport's runways in the next ten years. Closing a runway will require modification of the current operating configuration (two dedicated arrival runways, two dedicated departure runways). The Capacity Team evaluated two possible temporary operating configurations to determine the impacts of a runway closure. For this evaluation, the Capacity Team assumed the commuter runway would not be operational. Delay costs shown below are annualized costs, however, runway closure would be a temporary condition.

Estimated project construction cost is \$20 million each.

A. Arrivals and Departures on One Runway

Closing one runway would reduce one of the two runway pairs to a single operational runway. Under this scenario, this runway would handle both arrivals and departures. The other runway pair would operate normally (one dedicated departure runway, one dedicated arrival runway).

Increased annual delay cost at the Baseline activity level would be 25,640 hours or \$50.77 million; at Future 1, 110,690 hours or \$219.17 million; and, at Future 2 activity levels, 388,330 hours or \$768.89 million.

The Capacity Team recommends that this alternative not be implemented because the increased annual delay costs for this alternative are much greater than for alternative 5b, arrivals and departures on three runways.

B. Arrivals and Departures on Three Runways

Under this scenario, arrivals and departures would operate on all three remaining operational runways. This scenario would involve additional runway crossings for both arrivals and departures for the pair of open runways.

Annual delay savings at the Baseline activity level would be 7,050 hours or \$13.96 million, however increased annual delay costs are estimated at Future 1 to be 7,680 hours or \$15.21 million and, at Future 2 activity levels, increased costs are estimated at 90,670 hours or \$179.53 million.

The Capacity Team recommends that this alternative be implemented during runway reconstruction.

Facilities and Equipment Improvements

6. CAT II/III ILS on Runways 26R and 27L.

This improvement would permit sustained capacity during periods of low visibility in west flow conditions. Currently, controllers must reverse traffic flow from a westerly direction to an easterly direction when weather falls below CAT I minima. If this occurs during a peak arrival period, delays increase at ATL and throughout the Air Traffic Control System. Reversing the traffic flow direction during peak periods can require airborne holding of up to 60 aircraft for an average of 30 minutes each. Also, having to flow traffic in an easterly direction when weather falls below CAT I minimums can reduce safety by requiring aircraft to land with some tail-wind.

Estimated project cost is \$4.3 million.

The Capacity Team recommends that this improvement be implemented as soon as possible.

7. CAT IIIB ILS on Runway 8L.

A. Approaches with less than 600' RVR

The City of Atlanta is preparing to groove Runway 9R to enable the restoration of CAT IIIB ILS approaches to the runway during low visibility conditions with less than 600' RVR. Similar improvements to Runway 8L would also allow CAT IIIB ILS approaches to this runway during low visibility conditions with less than 600' RVR; thereby allowing two arrival streams and doubling arrival capacity during these conditions. The improvement would involve additional pavement marking and lighting, an ILS equipment upgrade, and revisions to the airport's Surface Movement Guidance and Control System (SMGCS) Plan.

The Capacity Team recommends that this improvement be implemented as soon as possible.

B. Departures with less than 600' RVR

Currently, departures at ATL cannot be conducted in low visibility conditions less than 600' RVR. Additional pavement marking and lighting and revisions to the SMGCS Plan would be required to conduct these operations. Also, the users would need to conduct special pilot training and install approved operational vision enhancement devices, such as "heads-up" displays, in the cockpits of their aircraft.

The Capacity Team recommends that this improvement be implemented as soon as possible.

8. New Independent Runway 9S/27S, Approach Aides.

A. CAT I Approaches

This improvement, along with the PRM (Improvement 9), would allow simultaneous, independent precision approaches to three runways during weather conditions down to Category I (CAT I) approach minimums. The Improvement would include the installation of the

necessary CAT I instrument landing system (ILS) equipment, approach lights, and touchdown runway visual range (RVR) equipment. The new Global Positioning System (GPS) technology may be available in the 1998-2000 time-frame. This would eliminate the need for the ground based ILS localizer and glide slope equipment, thus reducing the cost of this improvement. However, the approach lights and RVR equipment would still be required and users would need to install the necessary GPS avionics.

Estimated project cost is \$3.0 million (F&E equipment costs only).

Annual delay savings at the Baseline activity level would be 3,850 hours or \$7.63 million; at Future 1, 30,670 hours or \$60.71 million; and, at Future 2 activity levels, 84,240 hours or \$166.8 million. These savings are included in the savings of improvement number 1.

The Capacity Team recommends that this improvement be implemented at the Future 1 demand level.

B. CAT II Approaches

This improvement, along with the PRM (Improvement 9), would allow simultaneous independent approaches to three runways during periods of low visibility conditions down to Category II (CAT II) approach minimums. The improvement would include the installation of the necessary CAT II ILS equipment, approach lights, touchdown and rollout runway visual range (RVR) equipment, touchdown zone lights, and centerline lights. It would also require the users to install the necessary CAT II ILS avionics. GPS technology may be capable of supporting CAT II approaches in the 2000-2004 time-frame. This would reduce the ground based equipment required, thus the cost of this improvement would be reduced. However, the approach lights, RVR equipment, and ground based GPS differential equipment would still be required, and users would need to install the necessary GPS avionics.

Estimated project cost is \$5.0 million (F&E equipment costs only).

Annual delay savings at the Baseline activity level would be 3,090 hours or \$6.11 million; at Future 1, 13,360 hours or \$26.45 million; and, at Future 2 activity levels, 22,340 hours or \$44.23 million. These savings are included in the savings of improvement number 1.

The Capacity Team recommends that this improvement be implemented at the Future 1 demand level.

9. Precision Runway Monitor (PRM), Final Monitor Aid (FMA).

Where closely-spaced parallel runways exist, the proximity of arrival paths precludes independent parallel instrument approaches when the weather is less than the required minimum for visual approaches. Significant capacity gains can be achieved through use of a PRM system. The PRM is a new high-update-rate radar system. Demonstrations of PRM technology were conducted in 1989 and 1990 and resulted in the publication of procedures for independent parallel approaches to runways having centerlines separated by 3,400 feet to 4,299 feet. Application of these procedures is contingent upon the use

of PRM technology. Additional simulations are being conducted at the FAA Technical Center to determine the minimum runway spacing (below 3,400 feet) for independent parallel approaches utilizing a PRM.

The FMA is a high resolution color display which is equipped with the controller alert hardware and software used in the PRM system. The display includes alert algorithms which provide aircraft track predictors; a color change alert when an aircraft penetrates or is predicted to penetrate the no transgression zone (NTZ); a color change alert if the aircraft transponder becomes inoperative; and digital mapping. Studies revealed that using the FMA with current radar systems would improve the ability of controllers to detect blunders, thereby allowing a reduction in the minimum centerline spacing for independent parallel approaches.

After the new Runway 9S/27S is implemented, installation of the PRM/FMA system will allow simultaneous, independent precision instrument approaches to three runways during all weather conditions. This will give air traffic controllers the flexibility to conduct arrivals to the new runway independently of the operations on the existing two arrival runways, thus reducing controller workload and enhancing airport capacity.

Estimated project cost is \$9.0 million.

The Capacity Team recommends that this improvement be implemented at the Future 1 demand level.

10. Wake Vortex Avoidance System (WVAS).

Under current conditions, controllers cannot detect the presence of wake vortices. Therefore, to guard against these potential hazards, increased separations between aircraft are maintained. The Wake Vortex Avoidance System (WVAS) increases capacity by permitting reduced spacing between aircraft when wake vortices present no hazards to following aircraft. It is anticipated that joint FAA and National Aeronautics and Space Administration (Langley) efforts, utilizing a radar type sensing technology named the Automated Vortex Sensing System (AVSS), will yield an operational system by 1998.

The Capacity Team recommends that this improvement be implemented as soon as possible.

A. Arrivals and Departures on Three Runways

The results of this experiment indicate the benefit that could be obtained if all wake vortex separations were eliminated all of the time. Savings shown below are possible if all wake vortex turbulence dependencies among aircraft are eliminated. Therefore, this is the maximum possible savings and the actual savings would be less.

Annual delay savings at the Baseline activity level would be 16,530 hours or \$32.73 million; at Future 1, 33,890 hours or \$67.10 million; and, at Future 2 activity levels, 65,740 hours or \$130.17 million.

B. Arrivals and Departures on Four Runways

The results of this experiment indicate the benefit that could be obtained if all wake vortex separations were eliminated all of the time. Savings shown below are possible if all wake vortex turbulence dependencies among aircraft are eliminated. Therefore, this is the maximum possible savings and the actual savings would be less.

Annual delay savings at the Baseline activity level would be 20,960 hours or \$41.50 million; at Future 1, 54,190 hours or \$107.30 million; and, at Future 2 activity levels, 146,050 hours or \$289.18 million.

11. Integrated Terminal Weather System (ITWS).

The ITWS is an upgrade to the current Doppler weather radar. The ITWS program will provide improved aviation weather information in the terminal area by integrating data and products from various FAA and National Weather Service (NWS) sensors and weather information systems. A key objective of the program is to increase the airport's effective flow rate by providing controllers with better and more timely weather information. Controller workload would be reduced by providing tailored, timely information to pilots directly by data-link and by reducing the need for controller interpretation of weather reflectivity images. Safety would be enhanced by providing earlier warnings for wind shear, by identifying hazardous storms, and by providing support for ground deicing decision making.

The Capacity Team recommends that this improvement be implemented as soon as possible.

12. Airport Research Management Tool (ARMT)/Surface Movement Advisor (SMA).

In January 1995, the Atlanta Airport was selected as the prototype airport for the development of a new electronic data communications system designed to share an unprecedented level of information between the FAA and aviation users called the Surface Movement Advisory (SMA). The SMA Program Office incorporated the concept and design of the locally developed FAA/Industry prototype program referred to as the Atlanta Airport Resource Management Tool (ARMT) program into the SMA. The ARMT program, developed during 1991-1995, is serving as a baseline build for the national prototype SMA program and will eventually be fully incorporated into the national SMA program.

SMA will exchange electronic real-time aircraft movement data messages and share that information with SMA customers. Initially, the primary customers of SMA are intended to be the FAA's Atlanta airport traffic control tower, Atlanta ARTC Center, the National Central Flow Control Facility and valid Atlanta airport users. An SMA program milestone is to bring the conceptual design to full reality and functionality at the Atlanta airport beginning in 1996.

The present ARMT system and the future SMA program design will provide for the sharing of an unprecedented level of accurate real-time information with airport users. This information sharing will enable users to see demand and performance within the real-time ATC

system as it occurs. SMA data will provide information to users which highlights opportunities for better airport balancing and utilization decisions. These decisions have the potential to result in a much greater utilization of existing airport capacities than ever before envisioned.

The real-time display and use of SMA/ARMT data will facilitate better planning and analysis by all parties to the system. Such real-time analysis is expected to result in a more efficient balancing of the demand and utilization of the available airport surface movements areas. The level of real-time information provided by SMA/ARMT will enable diverse parties (controllers and airlines) to consult the same data information set for the first time. This system should empower all parties to make dynamic real-time decisions about the entry or exit of aircraft in the ATC system since supervisors, traffic management specialists, controllers and aviation users will be able to see real-time demand before aircraft even begin moving.

The SMA system is designed to process numerous daily airport activity data messages. User schedules, schedule changes, gate changes, ready to push messages, push back time, ground gate arrival time, real-time ARTS IIIA system aircraft tracking movement events, and weather reporting will serve as fundamental sources of data. The raw SMA data will be processed, analyzed, and displayed in several common arrival and departure formats. These information displays will then be provided to remote user systems connected to the SMA network. This design will enable instantaneous communication of the current status of the ATC system in terms of arrival and departure demand and performance data for each airport runway complex. Existing and planned traffic management programs, flow restrictions and weather initiatives will also be included, processed, and displayed on a real-time basis through the SMA system at a future date.

The use of either the ARMT or SMA system should result in more timely dynamic decisions which have the potential to save the aviation system millions of dollars.

The Capacity Team recommends that this improvement be implemented as soon as possible.

Operational Improvements

13. Reduced In-Trail Spacing to 2nm (IFR Arrivals).

The minimum in-trail separation under IFR for aircraft within the terminal area inside the outer marker is 2.5nm when wake turbulence is not a factor. When wake turbulence is a factor (e.g., when a small aircraft trails a heavy jet), separations can be as high as 6nm within the terminal area. This option would reduce minimum in-trail separations under IFR to 2.0nm unless wake turbulence separation requirements dictate otherwise.

Reduced in-trail separations would increase arrival runway capacity because more aircraft would be able to land on a runway during any given time period. The capacity team noted, however, that if in-trail separations are reduced, it may be necessary to construct new high-

speed exits and make more efficient use of existing high-speed exits so that runway occupancy times (ROT's) are reduced to a level that does not restrict departure flow and an excessive number of missed approaches do not occur.

Annual delay savings at the Baseline activity level would be 3,010 hours or \$5.96 million; at Future 1, 16,420 hours or \$32.51 million; and, at Future 2 activity levels, 28,250 hours or \$55.94 million.

The Capacity Team recommends that a further, more detailed study be conducted before this improvement is implemented.

14. Departures from 3 or 4 Runways.

Simultaneous (independent) jet departures are currently not conducted at the Airport on the close parallel runways (Runways 9R/27L and 9L/27R and Runways 8L/26R and 8R/26L) during any conditions.

Procedures were simulated to release departures on closely spaced parallel runways. These procedures have departure/departure dependencies. This improvement examined the existing airport configuration without the commuter runway. The modeling simulated these procedures throughout the entire day, not during departure pushes only.

Implementing the new procedures described in a and b below would require new jet departure routes. In addition, the necessary environmental documentation and a revision to the airport's Federal Aviation Regulation, Part 150 noise compatibility plan would be required..

A. Departures from Three Runways

The procedure simulated departures from Runways 8R/26L, 9L/27R, and 9R/27L with arrivals to Runways 8L/26R and 9R/27L. At Future 1, due to increased arrivals, this procedure reached a saturation point where additional departures could not be accommodated. Therefore, at or above this traffic level, this procedure resulted in an increase in delay.

Annual delay savings at the Baseline activity level would be 3,980 hours or \$7.88 million.

At Future 1, the increased delay costs are estimated at 3,170 hours or \$6.28 million; and, at Future 2, the increased delay costs are 25,950 hours or \$51.38 million.

The Capacity team does not recommend implementation of this improvement.

B. Departures from Four Runways

The procedure simulated departures from all four runways with arrivals to Runways 8L/26R and 9R/27L. At Future 2, due to increased arrivals, this procedure reached a saturation point where additional departures could not be accommodated. Therefore, at or above this traffic level, this procedure resulted in an increase in delay.

Annual delay savings at the Baseline activity level would be 9,680 hours or \$19.17 million and, at Future 1, 9,060 hours or \$17.94 million.

At Future 2, increased delay costs are estimated to be 11,920 hours or \$23.60 million.

The Capacity team does not recommend implementation of this improvement.

C. Departures from Three Runways (Turboprops only on 9R)

The procedure simulated departures from Runways 8R/26L, 9L/27R, and 9R/27L with arrivals to Runways 8L/26R and 9R/27L, but with turboprop departures only on Runway 9R. Since turboprops can turn immediately after departure, it assumed three departure fixes for the turboprops which allows more departures from the airport. With this procedure, saturation was not reached.

Annual delay savings at the Baseline activity level would be 5,360 hours or \$10.61 million; at Future 1, 11,600 hours or \$22.10 million; and, at Future 2, 14,260 hours or \$28.23 million.

The Capacity Team recommends that this improvement be implemented as soon as possible.

15. Improved Operations on Parallel Runways Separated by less than 2,500' (Reduced Wake Vortex Restrictions for Departure Runways).

Current procedures consider parallel runways separated by less than 2,500 feet as a single runway during IFR operations. Simultaneous use of these runways for departures is prohibited. This imposes a significant capacity penalty at numerous high-density airports. Procedures were simulated to release the departures on the closely spaced parallel runways. The procedures did not have wake vortex departure/departure dependencies. This improvement examined the existing airport configuration without the commuter runway.

The Capacity Team recommends that this improvement be implemented at the Future 1 demand level.

A. Three Departure Runways

The procedure simulated the departures from Runways 8R/26L, 9L/27R, and 9R/27L with arrivals to Runways 8L/26R and 9R/27L.

Annual delay savings at the Baseline activity level would be 11,660 hours or \$23.09 million; at Future 1, 17,640 hours or \$34.93 million; and, at Future 2 activity levels, 24,410 hours or \$48.33 million.

B. Four Departure Runways

The procedure simulated departures from all four runways with arrivals to Runways 8L/26R and 9R/27L.

Annual delay savings at the Baseline activity level would be 14,180 hours or \$28.08 million; at Future 1, 27,370 hours or \$54.19 million; and, at Future 2 activity levels, 37,870 hours or \$74.98 million.

16. Ramp Control on Ramp 4.

The 1987 Atlanta Airport Capacity Team addressed airport capacity due to increased Hub and commuter operations. During the time of that study, Ramp 4 traffic was controlled by Eastern Airlines from the C Concourse Tower. Since the 1987 study, several carriers operating from C and D concourses have gone out of business and Ramp 4 became an uncontrolled ramp. As of the 1995 Capacity Team Study, Ramp 4 traffic is back to the 1987 level and Ramp 4 remains uncontrolled. This Team could not project annual savings by staffing the Ramp 4 tower due to the diverse operations by concourse C and D users and no history of savings prior to 1987. It is recognized that controlling Ramp 4 traffic would enhance operational safety. Also, in conjunction with other recommendations by this Team, i.e., ARMT and SMA, there would be a more efficient movement of traffic into and out of Ramp 4. With all users tied into ARMT, Atlanta Tower personnel could affect more timely coordination with the users of Ramp 4 through the Ramp Tower; thereby eliminating many delays caused by very limited communications capability with the users of Ramp 4. By eliminating delays, savings to the users would be recognized. Therefore, the Capacity Team recommends this improvement be implemented as soon as possible.

User or Policy Improvements

17. Uniformly Distribute Scheduled Commercial Operations.

A more uniform distribution of airline flights during peak periods would promote a more orderly flow of traffic, reduce arrival and departure delays, and reduce ground congestion near the terminal and on the taxiway system.

However, ATL is part of hub-and-spoke operations, and uniform distribution of traffic is not consistent with such an operation. Hubbing creates efficiencies that cannot be measured in a delay study of this type. This system of operations provides frequent service between city-pairs that could not support frequent direct service. Frequent flights provide an economic benefit to consumers, in particular the business flyer. Therefore, the Capacity Team does not recommend that this improvement be implemented.

18. Impact of Noise Abatement Restrictions With Current Jet Aircraft Fleet.

A review of the present noise abatement procedures/restrictions, implemented prior to FAR 36 Aircraft and the use of current operating procedures, is necessary. This situation has resulted in a mismatch between the original noise abatement needs and current operations.

Due to current noise abatement restrictions, the annual delay costs increase at the Baseline activity level by 7,450 hours or \$14.75 million; at Future 1, 12,140 hours or \$24.04 million; and, at Future 2 activity levels, 29,930 hours or \$59.26 million.

Therefore, the Capacity Team recommends that every effort be made to encourage both noise reduction improvements and greater use

of airport facilities in order to meet arrival and departure demand. Analysis of the data indicates that any reduction in delay that could occur from reducing the effect of noise restrictions is dependent upon the actual distribution of traffic within the hours specified. Time within the hour is significant in the delay encountered by each aircraft, and spreading traffic out during the evening and early morning hours reduces delay even at the higher activity levels.

The Capacity Team recommends further study of this issue, changes could be part of the ATL Master Plan review.

19. Enhance Reliever and General Aviation (GA) Airport System.

Reliever and GA airports can ease capacity constraints by attracting small/slow aircraft away from primary airports, especially where small/slow aircraft constitute a significant portion of operations. The segregation of aircraft operations by size and speed increases effective capacity because required time and distance separations are reduced between planes of similar size and speed.

The Capacity Team recommends the continuing development and enhancement of the reliever and GA airport system around ATL. The Capacity Team also recommends that no actions be taken to divert small/slow aircraft to other airports in the region because there are relatively few small/slow aircraft operations at the airport, and these operations are often delivering passengers or freight to connect with commercial flights.

SECTION 4

SUMMARY OF TECHNICAL STUDY

Overview

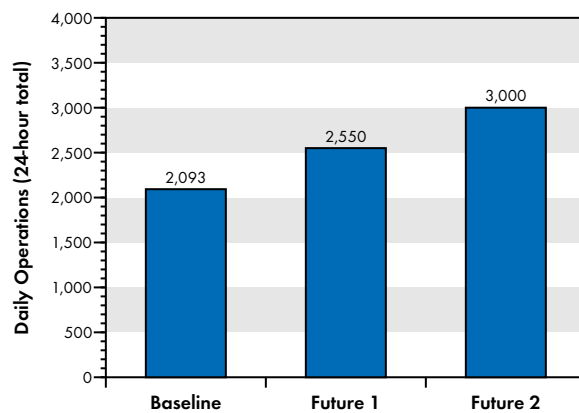
The Hartsfield Atlanta International Airport Capacity Team evaluated the efficiency of the existing airfield and the proposed future configurations. A brief description of the computer models and methodology used can be found in Appendix B. Certain standard inputs were used to reflect the operating environment at ATL. Details can be found in the data packages produced by the FAA Technical Center during the study. The potential benefits of various improvements were determined by examining airfield capacity, airfield demand, aircraft delays and travel times.

The Capacity Team used the Airport and Airspace Simulation Model (SIMMOD) and the Runway Delay Simulation Model (RDSIM) to determine aircraft delays and travel times during peak periods based on weather conditions, traffic distribution, runway use, and other variables. Daily operations corresponding to an average day in the peak month were used for each of the forecast periods. Figure 12 illustrates the average-day, peak-month demand levels for ATL for each of the three annual activity levels used in the study, Baseline, Future 1, and Future 2. Figure 13 shows airfield weather conditions and percentage of occurrence. Figure 14 provides the daily traffic demand distribution by aircraft class for the ATL fleet operating at the three demand levels. Figure 15 displays approach speeds by aircraft class and Figure 16 illustrates runway usage.

Delays were calculated for current and future conditions. Daily delays were annualized using a value of 333 equivalent days for all three demand levels. The annualized delays provided a basis for determining the benefits of the proposed improvements. The annualized delay of each improvement was subtracted from the annualized delay for the “Do Nothing” case to determine its benefit in terms of delay savings.

The aircraft fleet mix at ATL has a weighted-average direct operating cost of \$1,980 per hour, or \$33 per minute. These figures are based on the Atlanta daily traffic sample, type of aircraft distribution and operating cost data for scheduled and non-scheduled operations. They represent the costs for operating the aircraft and include such items as fuel, maintenance, and crew costs, but they do not consider lost passenger time, disruption to airline schedules, or other non-traditional factors.

The annualized delay savings of each improvement was multiplied by the weighted-average aircraft direct operating cost to determine its delay cost savings. The implementation cost of a particular improvement was compared to its annual delay cost savings. This comparison indicated which improvements would be of most value and, therefore, recommended by the Design Team.

Figure 12. Annual and Daily Demand Levels

	Annual Operations	Daily Operations	Equivalent Days
Baseline	700,000	2,093	333
Future 1	850,000	2,550	333
Future 2	1,000,000	3,000	333

Figure 13. Airfield Weather

	Ceiling	Visibility	Occurrence
VFR 1	5,000 ft.	5 miles	52%
VFR 2	1,000 ft. - 5,000 ft.	3 - 5 miles	35%
IFR 1	200 ft. - 1,000 ft.	2,400 ft. RVR - 3 miles	11%
IFR 2	0 ft. - 200 ft.	600 ft. RVR - 2,400 ft. RVR	2%

Figure 14. Daily Traffic Demand Distribution by Aircraft Class

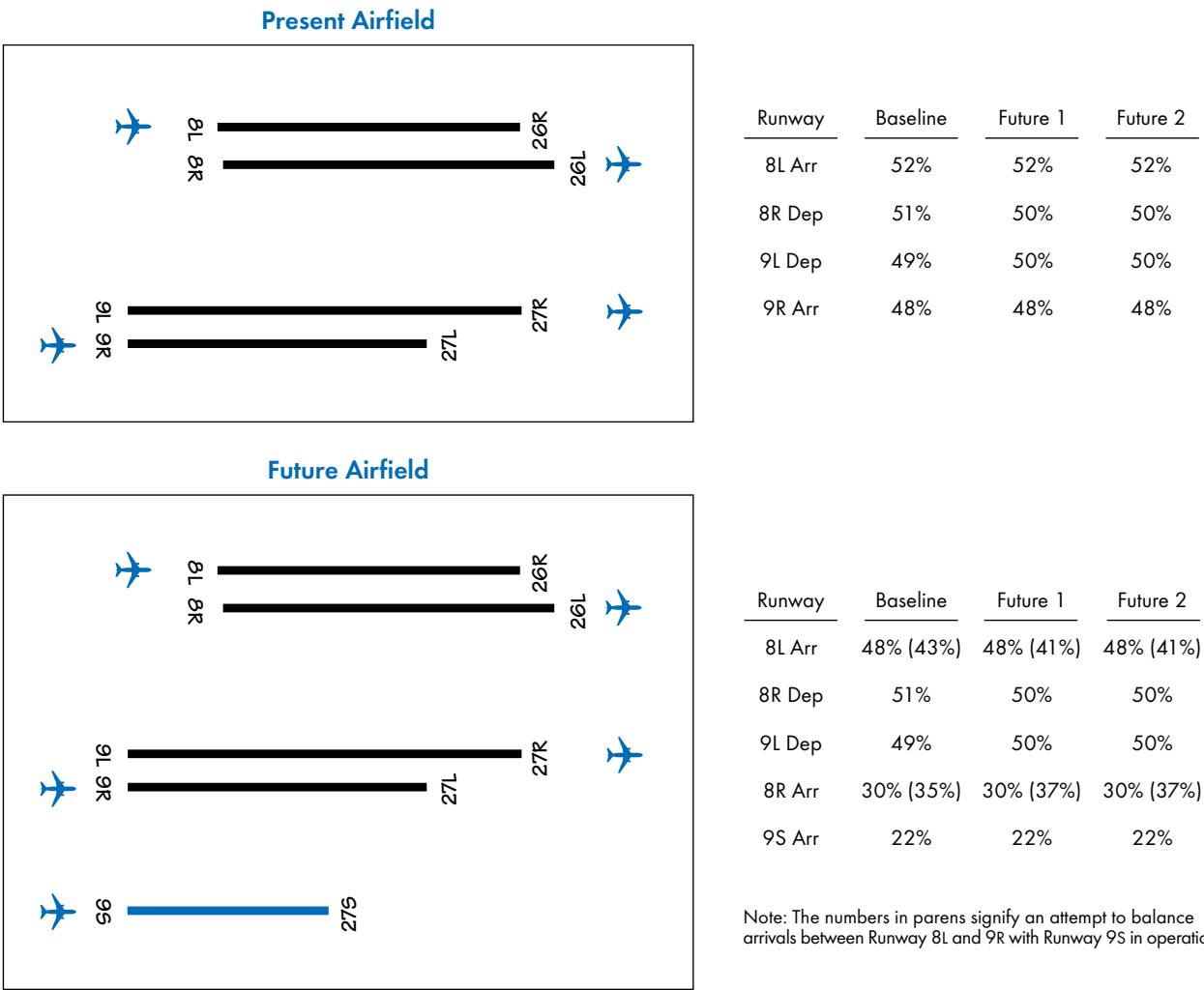
New Class ^a	Original Class ^b	Type of Aircraft ^c	Baseline 700,000	Future 1 850,000	Future 2 1,000,000
1	1	Small single-engine/twin-engine aircraft (prop) weighing 12,500 pounds or less (e.g., C208, C210, 172RG/BE55, C414, PA31)	3%	3%	2%
2	2	Large aircraft (prop) weighing more than 12,500 pounds and up to 100,000 pounds (e.g., AT72, BA31, EM2, SF34)	19%	20%	22%
3	2	Large aircraft (jet) weighing more than 12,500 pounds and up to 100,000 pounds (e.g., C560, FK10, LR35)	4%	5%	5%
4	2	Large aircraft weighing more than 100,000 pounds and up to 300,000 pounds (e.g., B737, B727, DC9, EA32, MD88)	51%	45%	41%
5	2	Large (B757) - Special class aircraft	8%	12%	14%
6	3/4	Heavy aircraft weighing more than 300,000 pounds (e.g., A300, B707, -300 -400 Series, B747, B767, Concorde, DC8S, IL62, L1011)	15%	15%	16%

- a. Factors considered by the Design Team for this new classification of aircraft include approach speeds; how arrivals are separated at the point of closest approach; and take-off weights for consideration in future airfield development.
- b. Classes used in 1987 Capacity Enhancement Plan
- c. For aircraft designator, see FAA Handbook 7340.1E with changes
Weights refer to maximum certified takeoff weights
Heavy aircraft are capable of takeoff weights of 300,000 pounds or more, whether or not they are operating at this weight during a particular phase of flight (reference FAA Handbook 7110.65 with changes)

Figure 15. Aircraft Approach Speeds (Knots)

Speed (knots)	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Standard IFR 2	140	130	130	130	130	120
Modified IFR 1	150	140	140	140	140	135
Atlanta VFR 1 & 2	156	143	154	147	147	153

Figure 16. Percentage of Runway Use — Current and Future Airfield - East Flow (West Flow Similar)



Airfield Capacity

The ATL Capacity Design Team defined airfield capacity to be the maximum number of aircraft operations (landings and takeoffs) that can take place in a given time under given conditions. Airfield capacity is a complex issue that cannot be represented by a single value, but changes as conditions change. The following conditions were considered:

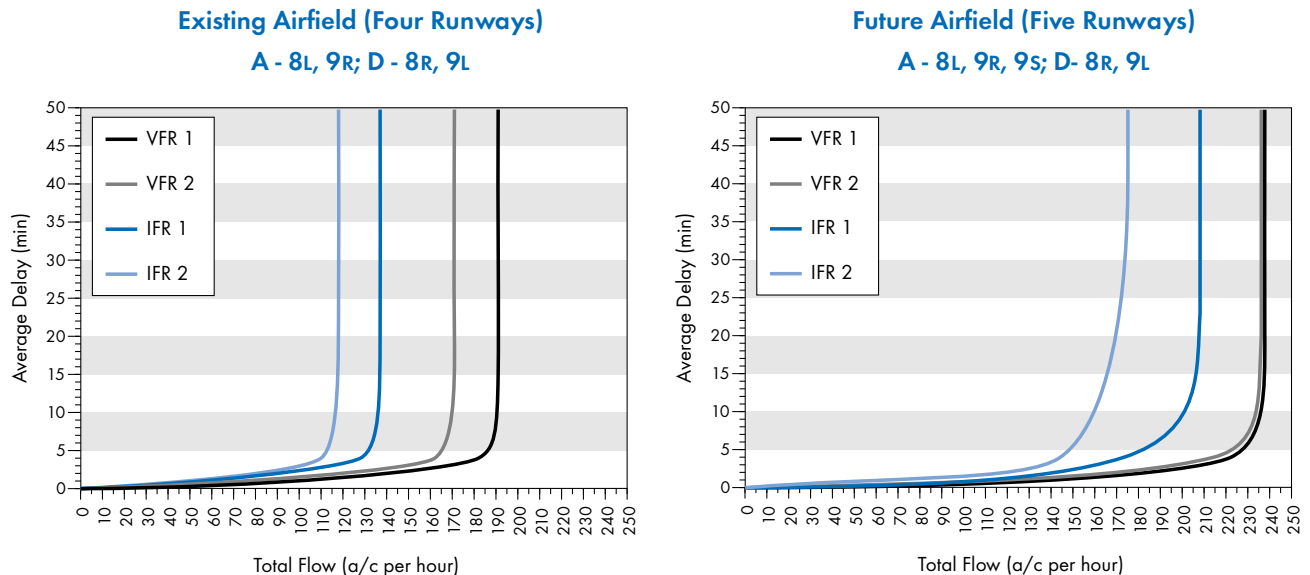
- Level of delay.
- Airspace constraints.
- Ceiling and visibility conditions.
- Runway layout and use.
- Aircraft mix.
- Percent arrival demand.

The curves in Figure 17 illustrate the relationship between airfield capacity, stated in the number of operations per hour, and the average delay per aircraft — as the number of aircraft operations per hour increases, the average delay per operation increases exponentially.

Comparing the information in Figures 4 and 17 shows that:

- Aircraft delays will begin to rapidly escalate as hourly demand exceeds 125 operations per hour under IFR conditions, and,
- While hourly demand exceeds 125 operations during certain hours of the day at Baseline demand levels, 125 operations per hour is frequently exceeded at the Future demand levels.

Figure 17. Airport Capacity Curves — Hourly Flow Rate Versus Average Delay 50/50 Demand Split East Flow (West Flow Similar)



Aircraft Delays

Aircraft delay is defined as the time above the unimpeded travel time for an aircraft to move from its origin to its destination. Aircraft delay results from interference from other aircraft competing for the use of the same facilities.

The major factors influencing aircraft delays are:

- Ceiling and visibility conditions.
- Airfield and ATC system demand.
- Airfield physical characteristics.
- Air traffic control procedures.
- Aircraft operational characteristics.
- Fleet Mix.

	Annual Delay Costs	
	Hous	Millions of 1995 \$
Baseline	75,050	\$148.60
Future 1	177,870	\$348.63
Future 2	443,210	\$877.56

Note: Annualized values were computed using the ATL aircraft fleet weighted-average direct operating cost of \$1,980 per hour or \$33 per minute of airport time.

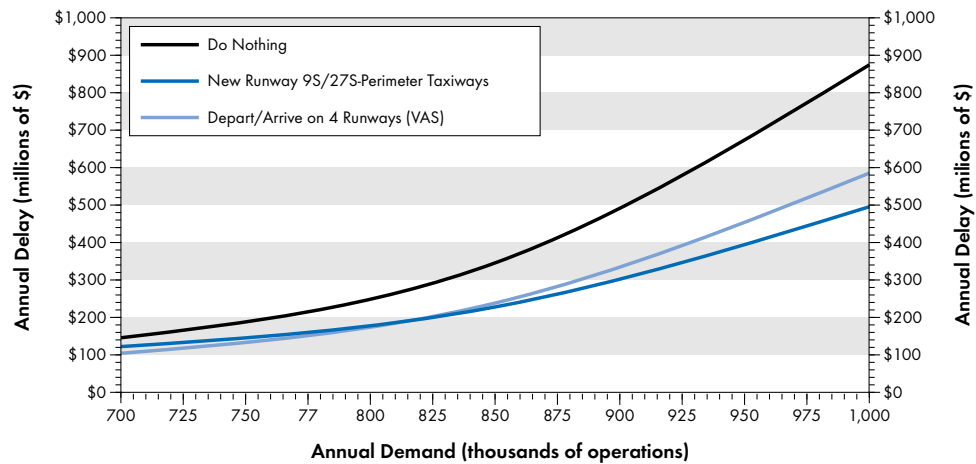
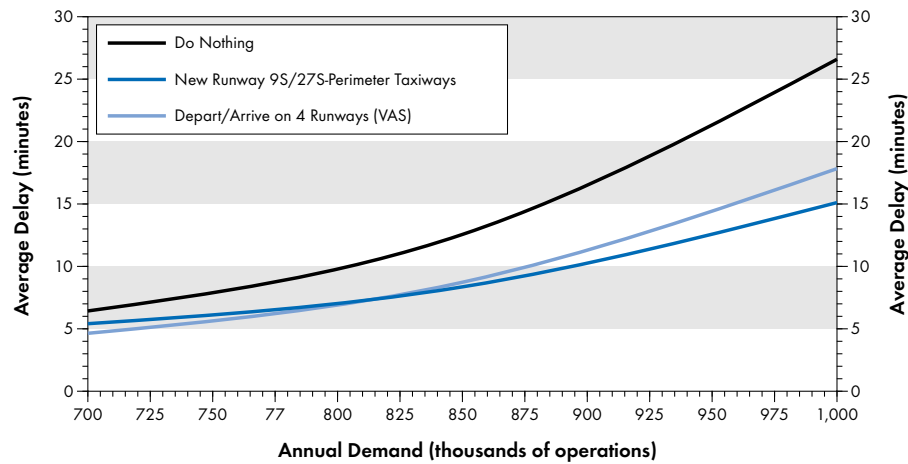
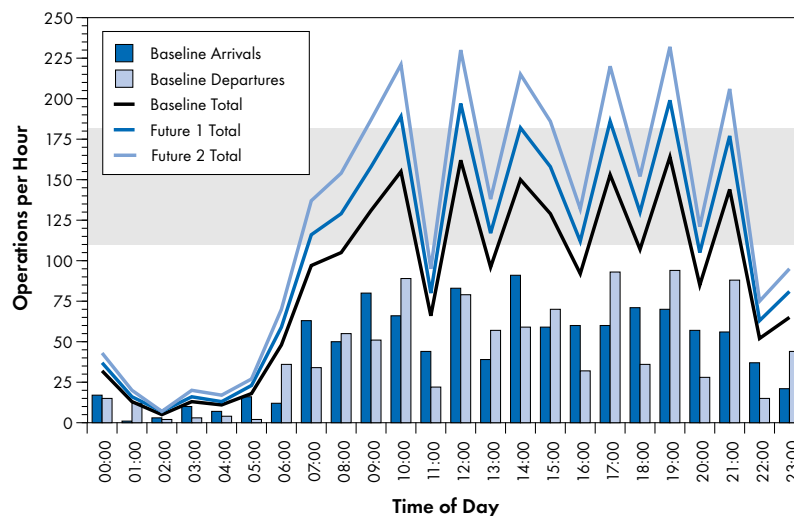
Total daily delays in minutes were generated by the Airport and Airspace Simulation Model (SIMMOD). A description of this model is included in Appendix B. The daily delays were converted from minutes to hours and annualized. If no improvements are made in airport capacity, the annual delay of 147,000 hours at the Baseline level of operations will increase to 266,360 hours by Future 1 and 547,050 hours by Future 2. Under this Do Nothing scenario (no improvements in airfield capacity with no gate capacity constraints), the annual delay cost are predicted to increase as shown in the table to the left.

Conclusions

Figure 18 demonstrates the impact of delays at Hartsfield Atlanta International Airport. The chart shows how delay costs will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario. The graph also shows that the greatest savings in delay costs would be provided by:

- New Independent Runway 9S/27S
- Arrivals Use Perimeter Taxiway
- Arrivals Use Taxiway R
- Arrivals Use Taxiway N
- Departure/Arrivals on 4 Runways/VAS

Figure 19 illustrates the average delay in minutes per aircraft operation for these alternatives. Under the existing airfield alternative (if there are no improvements made in airfield capacity) the average delay per operation of 6.4 minutes at the Baseline level of activity will increase to 12.6 minutes per operation by Future 1 and 26.6 minutes per operation by Future 2. Figure 20 profiles ATL daily demand on an hourly basis.

Figure 18. Delay Costs — Capacity Enhancement Alternatives**Figure 19. Average Delays — Capacity Enhancement Alternatives****Figure 20. Profile of Daily Demand — Hourly Distribution**

APPENDIX A

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APPENDIX B

COMPUTER MODELS AND METHODOLOGY

The ATL Capacity Team studied the effects of various improvements proposed to reduce delay and enhance capacity. The options were evaluated considering the anticipated increase in demand. The analysis was performed using computer modeling techniques. A brief description of the models and the methodology employed follows.

Computer Models

Runway Delay Simulation Model (RDSIM)

RDSIM is a short version of the Airfield Delay Simulation Model (ADSIM). ADSIM is a fast-time, discrete event model that employs stochastic processes and Monte Carlo sampling techniques. It describes significant movements of aircraft on the airport and the effects of delay in the adjacent airspace. The model was validated in 1978 at Chicago O'Hare International Airport against actual flow rates and delay data.

RDSIM, on the other hand, simulates only the runways and runway exits and adjacent airspace. There are two versions of the model. The first version ignores the taxiway and gate complexes for a user-specified daily traffic demand and is used to calculate daily demand statistics. In this mode, the model replicates each experiment forty times, using Monte Carlo sampling techniques to introduce system variability, which occurs on a daily basis in actual airport operations. The results are averaged to produce output statistics. The second version also simulates the runway and runway exits only, but it creates its own demand using randomly assigned arrival and departure times. The demand created is based upon user-specified parameters. This form of the model is suitable for capacity analysis.

For this study, RDSIM was calibrated against field data collected at ATL to ensure that the model was site specific. For a given demand, the model calculated the hourly flow rate and average delay per aircraft during the full period of airport operations. Using the same aircraft mix, simulation analysts simulated different demand levels for each run to generate demand versus delay relationships.

Airport and Airspace Simulation Model (SIMMOD)

SIMMOD is a fast-time, event-step model that simulates the real-world process by which aircraft fly through air traffic controlled en route and terminal airspace and arrive and depart at airports. SIMMOD traces the movement of individual aircraft as they travel through the gate, taxiway, runway, and airspace system and detects potential violations of separations and operation procedures. It simulates the air traffic control actions required to resolve potential conflicts to insure that aircraft operate within procedural rules. Aircraft travel time, delay, and traffic statistics are computed and provided as model outputs. The model was calibrated for this study against field data collected at ATL to ensure it was site specific. Inputs for the simulation model were also derived from empirical field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability. The results were then averaged to produce output statistics.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, different airfield configurations were derived from present and projected airport layouts. The projected implementation time for air traffic control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, Technical Center specialists developed traffic demand distributions based on the *Official Airline Guide*, historical data, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for three demand periods, Baseline, Future 1, and Future 2. The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the yearly variations in runway configurations, weather, and demand based on historical data.

The potential delay reductions for each improvement were assessed by comparing its annual delay estimates with the delay estimates for the Do Nothing case.

Summary Data Package available as a Technical Note publication through the FAA Technical Center:

FAA Technical Center
Management Services Branch
Technical Library, ACM-620A
Atlantic City International Airport, NJ 08405

APPENDIX C

LIST OF ABBREVIATIONS

ADSIM	Airfield Delay Simulation Model
ARMT	Airport Research Management Tool
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASC	Office of Aviation System Capacity, FAA
ASDE	Airport Surface Detection Equipment
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
ATL	Hartsfield Atlanta International Airport
CAT	Category — of instrument landing system
CEP	Capacity Enhancement Plan
FAA	Federal Aviation Administration
FMA	Final Monitor Aid
GA	General Aviation
GPS	Global Positioning System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
ITWS	Integrated Terminal Weather System
LBS	Pounds
MLS	Microwave Landing System
NM	Nautical Miles
PRM	Precision Runway Monitor
RDSIM	Runway Delay Simulation Model
ROT	Runway Occupancy Time
RVR	Runway Visual Range
SIMMOD	Airport and Airspace Simulation Model
SM	Statute Miles
SMA	Surface Movement Advisor
SMGCS	Surface Movement Guidance and Control System
SOIR	Simultaneous Operations on Intersecting Runways
TERPS	Terminal Instrument Procedures
TRACON	Terminal Radar Approach Control Facility
VAS	Vortex Advisory System
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range — course information only
WVAS	Wake Vortex Avoidance System

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Notes:

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